

LOAN DOCUMENT

PHOTOGRAPH THIS SHEET

①

INVENTORY

LEVEL

NRL-MR-192

DOCUMENT IDENTIFICATION
20 Jul 53

DISTINCTION STATEMENT A

Approved for public release
Distribution Unlimited

DISTRIBUTION STATEMENT

ACCESSION DATE	
NTIS	GRAM
DTIC	TRAC
UNANNOUNCED	
JUSTIFICATION	
BY	
DISTRIBUTION/	
AVAILABILITY CODES	
DISTRIBUTION	AVAILABILITY AND/OR SPECIAL
A-1	

DISTRIBUTION STAMP

DTIC QUALITY INSPECTED

DATE ACCESSIONED

DATE RETURNED

DATE RECEIVED IN RTIC

REGISTERED OR CERTIFIED NUMBER

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-FDAC

UNCLASSIFIED

NRL MEMORANDUM REPORT No. 192

FINAL REPORT ON
ENGINEERING EVALUATION OF SCANNING
SONAR EQUIPMENT MODEL QHD
SERIAL NO. 1

H. H. Elliott, Jr.
SOUND DIVISION

20 July 1953



NAVAL RESEARCH LABORATORY, WASHINGTON, D.C.

RECLASSIFIED: By authority of
OPNAVINST 8570.6 (4, 29 APR 88)
Date
Site Authority _____
C. ROGENS 1221.1
Entered by _____
NRL Code _____

UNITED STATES GOVERNMENT
memorandum

7103/123

DATE: 31 October 1996

FROM: Burton G. Hurdle (Code 7103)

SUBJECT: REVIEW OF REF. (a) FOR DECLASSIFICATION

TO: Code 1221.1

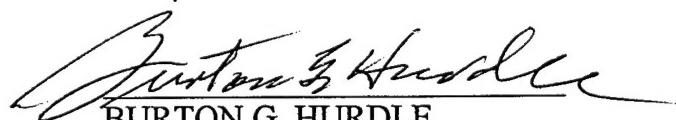
VIA: Code 7100

REF: (a) NRL Confidential Report #192 by H.H. Elliott, Jr., 20 July 1953 (U)

1. Reference (a) is a report on the engineering testing of Serial No. 1 of Model QHD scanning sonar equipment manufactured by Raytheon Mfg. Co., Submarine Signal Division, Waltham, Mass. The tests were conducted to determine if the equipment complied with the Navy's contractual specifications. The tests were extensive, including mechanical, electronic and electrical tests.

2. Serial No. 1 of Model QHD was the only one built. It was never put into operation. The technology of this equipment has long been superseded.

3. Based on the above, it is recommended that reference (a) be declassified with no restrictions.



BURTON G. HURDLE
Acoustics Division

CONCUR:



EDWARD R. FRANCHI 11/4/96
Superintendent
Acoustics Division

DISCLAIMER NOTICE



**THIS DOCUMENT IS BEST
QUALITY AVAILABLE. THE
COPY FURNISHED TO DTIC
CONTAINED A SIGNIFICANT
NUMBER OF PAGES WHICH DO
NOT REPRODUCE LEGIBLY.**

UNCLASSIFIED

TEXT

FOR

NRL MEMORANDUM REPORT NO. 192

DECLASSIFIED: By authority of
OPENING ST 5570. (H, 27 APR 88)

Cite Authority Date
C. ROGERS 1221.1
Entered by NRL Code

UNCLASSIFIED

FINAL REPORT
on
Engineering Evaluation of
Scanning Sonar Equipment
Model QHD
Serial No. 1

by

H. H. Elliott, Jr.

20 July 1953

Test Unit
Technical Services Staff
Sound Division
Naval Research Laboratory
Washington 25, D. C.

REFERENCES

- (a) BuShips conf ltr Ser 848-063 dtd 20 March 1950.
- (b) BuShips conf ltr Ser 848-0112 dtd 13 April 1950.
- (c) BuShips conf ltr Ser 848-081 dtd 28 March 1952.
- (d) BuShips restr ltr Ser 848-134 dtd 6 May 1952.
- (e) BuShips conf ltr Ser 814-017 dtd 3 March 1953.
- (f) BuShips Contract Specifications CS-774 dtd 15 May 1947, Scanning Sonar Equipment, Model QHD.
- (g) BuShips Contract Specifications CS-774 Addendum 2 dtd 1 August 1950.
- (h) Military Specifications MIL-S-15529 (SHIPS) dtd 1 August 1950, Modification to add Storage Feature.
- (i) Military Specifications MIL-S-15529 (SHIPS) Addendum 1 dtd 15 March 1951.
- (j) BuShips Specifications 16E4 (RE) dtd 15 May 1946 General Specifications for Electronic Equipment.
- (k) BuShips Specifications 16C39 (RE) dtd 15 June 1946 Components, Application of, for Electronic Equipment.
- (l) BuShips Specifications 16E4 (SHIPS) dtd 1 August 1949 General Specifications for Electronic Equipment.

UNCLASSIFIED

ABSTRACT

A production equipment, Serial Number 1 of the Model QHD Scanning Sonar Equipment manufactured by the Raytheon Manufacturing Company, Submarine Signal Division, Waltham, Mass., under contract NObsr-42064, was delivered to this laboratory for tests to determine compliance with references (f) and (g). The equipment was received 20 September 1951. A field change modification unit, the QHD Receiver Storage Scanner, was received 5 May 1952. Engineering evaluation of the equipment (less the modification unit) was started 12 December 1951. Testing of the modification unit to determine compliance with references (h) and (i) was started 22 May 1952. In compliance with reference (d) the transducer unit was returned to the manufacturer on 8 May 1952 for correction of fault in the MCC section and for modification of the rubber boot. The transducer was returned to this laboratory on 3 September 1952 and testing was resumed on 5 September 1952. As directed by reference (e) the completion of the Shock and Vibration tests was cancelled on 3 March 1953.

PROBLEM STATUS

This is a final report and concludes work on this problem.

AUTHORIZATION

NRL Problem S07-15

RDB NE-091106

BuShips Problem S-1508

TABLE OF CONTENTS

ABSTRACT

PROBLEM STATUS

AUTHORIZATION

REFERENCES

I. CONCLUSION

II. RECOMMENDATIONS

A. Mechanical

B. Electrical

C. Temperature and Humidity

 1. Mechanical

 2. Electrical

III. DESCRIPTION

A. General

B. Major Units

IV. INSPECTION, TESTS AND RESULTS

A. General

B. Mechanical - Individual Units

C. Electrical - Individual Units

D. Temperature and Humidity

 1. Mechanical

 2. Electrical

V. SHOCK AND VIBRATION

See NRL Memorandum Report No. 3853-354A/53

FIGURES

1. Linearity of SSI Vertical Sweep.
2. Scanning Receiver Overload Characteristics.
3. Scanning Receiver Frequency Response (Narrow Band-Pass Operation).
4. Scanning Receiver Frequency Response (Broad Band-Pass Operation).
5. Effect of TVG on Scanning Receiver Gain.
6. Effect of RCG and TVG on Scanning Receiver Gain-TVG Bias -25 v.
7. Effect of RCG and TVG on Scanning Receiver Gain-Fixed RCG.
8. First Oscillator ODN Operation.
9. Second Oscillator ODN Operation.
10. Listening Receiver Overload Characteristic.
11. Listening Receiver Frequency Response.
12. Effect of TVG on Listening Receiver Gain.
13. Effect of RCG and TVG on Listening Receiver Gain (TVG Bias -25 v).
14. Effect of RCG and TVG on Listening Receiver Gain (Fixed Amount of RCG).
15. Discriminator Characteristics.
16. SSI Receiver Phase Shift with Change in Input Frequency and Amplitude.
17. Driver Power Output.
18. Commutator Tube Overload Characteristic with the Coupling Amplifier.
19. QHD Transducer - Open Circuit Voltage Response and Transmitting Power Response of Individual Standard Staves at 26 kc.
20. QHD Transducer - Impedance and Phase Angle of Individual Standard Staves at 26 kc.
21. QHD Transducer - Sound Radiation Pattern for MCC Operation, Vertical Plane.
22. QHD Transducer - Sound Radiation Pattern for MCC Operation, Vertical Plane, Transducer Wires to MCC Section Reversed.
23. QHD Transducer - Transmitting Response of MCC Section, Horizontal Plane.
24. QHD Transducer - Resonance of Standard Section.
25. QHD Transducer - Transmitting Response of Standard Section.
26. QHD Transducer - Sound Radiation Pattern of Standard Section, Vertical Plane.
27. QHD Transducer - Horizontal Receiving Beam Pattern all Staves Connected in Parallel Aiding.
28. QHD Transducer - Receiving Beam Pattern after Commutation, Zero Degrees.
29. QHD Transducer - Receiving Beam Pattern after Commutation, 45 Degrees.
30. QHD Transducer - Receiving Beam Pattern after Commutation, 90 Degrees.
31. QHD Transducer - Receiving Beam Pattern after Commutation, 135 Degrees.
32. QHD Transducer - Receiving Beam Pattern after Commutation, 180 Degrees.
33. QHD Transducer - Receiving Beam Pattern after Commutation, 225 Degrees.
34. QHD Transducer - Receiving Beam Pattern after Commutation, 270 Degrees.
35. QHD Transducer - Receiving Beam Pattern after Commutation, 315 Degrees.
36. QHD Transducer - Stave No. 1 Transducer and Lens Network Receiving Beam Pattern without Commutation.
37. QHD Transducer - Stave No. 7 Transducer and Lens Network Receiving Beam Pattern without Commutation.

38. QHD Transducer - Stave No. 13 Transducer and Lens Network Receiving Beam Pattern without Commutation.
39. QHD Transducer - Stave No. 19 Transducer and Lens Network Receiving Beam Pattern without Commutation.
40. QHD Transducer - Stave No. 25 Transducer and Lens Network Receiving Beam Pattern without Commutation.
41. QHD Transducer - Stave No. 31 Transducer and Lens Network Receiving Beam Pattern without Commutation.
42. QHD Transducer - Stave No. 37 Transducer and Lens Network Receiving Beam Pattern without Commutation.
43. QHD Transducer - Stave No. 43 Transducer and Lens Network Receiving Beam Pattern without Commutation.
44. QHD Transducer - Sound Radiation Pattern of MCC Section Vertical Plane.
45. Storage Amplifier #41 - Frequency Characteristic.
46. Storage Amplifier AVC Characteristics.
47. Receiver Storage Amplifier AVC Delay Characteristics with 33-Millisecond Input Pulse Duration.
48. Alternating Current AVC Delay Characteristics of Storage Amplifier No. 35.
49. Receiver - Storage Amplifier AVC Delay Characteristics with 67-Millisecond Input Pulse Duration.
50. Receiver - Storage Amplifier AVC Delay Characteristics with 3.3-Millisecond Input Pulse Duration.
51. QHD Transmitting Frequency Variation with Temperature Change - First Oscillator Tuning Reactance Off.
52. QHD Transmitting Frequency Variation with Temperature Change - First Oscillator Tuning Reactance On.
53. First Oscillator Frequency Variation with Temperature Change - Tuning Reactance Off.
54. First Oscillator Frequency Variation with Temperature Change - Tuning Reactance On.
55. Second Oscillator Frequency Variation with Temperature Change - Operating at Transmitting Frequency.
56. Second Oscillator Frequency Variation with Temperature Change - with Tuning Reactance Off.
57. Second Oscillator Frequency Variation with Temperature Change - Tuning Reactance On.
58. Console Assembly.
59. Console Assembly - Open View, Bottom.
60. Console Assembly - Open View, Top.
61. Receiver Assembly.
62. Receiver Assembly - Right Side View.
63. Receiver Assembly - Left Side View.
64. Amplifier - Commutator Assembly.
65. Amplifier - Commutator Assembly - Front View, Open.
66. Amplifier - Commutator Assembly - Rear View.

- [REDACTED]
- 67. Servo Amplifier Assembly.
 - 68. Servo Amplifier Assembly - Front View, Open.
 - 69. Sonar Driver - Amplifier.
 - 70. Sonar Driver - Amplifier - Front View, Open.
 - 71. Transducer.
 - 72. Power Transformer.
 - 73. Motor - Generator Assembly.
 - 74. Motor Starter.
 - 75. Motor Starter - Open View.
 - 76. Relay Assembly.
 - 77. Relay Assembly - Open View.
 - 78. Receiver - Storage Scanner Assembly.
 - 79. Receiver - Storage Scanner Assembly - Front View, Open.
 - 80. Loudspeaker.
 - 81. Azimuth Range Indicator (Remote PPI).
 - 82. Azimuth Range Indicator (Remote PPI) Side View.
 - 83. Azimuth Range Indicator (Remote SSI).
 - 84. Azimuth Range Indicator (Remote SSI) Side View.
 - 85. Operator's Chair.
- [REDACTED]

1. CONCLUSION

The results of the specification compliance tests showed that the equipment, exclusive of the transducer, the transducer having failed nearly all of the specification requirements, was in general well designed, and when operation of the entire equipment was obtained it appeared to be a very capable sonar system. However, due to the many modes of operation with their associated test switches the system was made extremely complex. This complexity of the system resulted in an equipment that was somewhat unstable and required frequent adjustment. Due to the great amount of servicing and testing required to ensure optimum performance, it is concluded that the system is not suitable for Naval service where consistent operation is required.

II. RECOMMENDATIONS

A. Mechanical

1. Dimensions of units (including knobs, mounts etc.), should be within the limits specified in ref. (f), par. E-25.
2. Accessibility for servicing of the power supply units in the Receiver Assembly and in the Amplifier Commutator Assembly should be improved. (Ref. (j), par. D-2a..)
3. Supports for receiver chassis cover plates should be re-positioned in order that cover plate screws may more easily be removed and reinserted and to prevent damage to panel gasket when removing screws.
4. Screws, bolts, etc., should be so positioned as to eliminate hazard of shorting to ground or damaging electronic components.
5. Locking devices should be provided for holding console hinged panel (lower right control panel) in the maintenance position. (Ref. (j), par. D-2a(3).)
6. Holding bolts, when firmly seated, should securely hold and position the component parts. Loose or stripped bolts, nuts, etc., are not acceptable. (Ref. (j), par. D-17o(4).)

7. Screws or bolts secured by nuts or other retainers should not project beyond the retaining device by more than 1/8-inch plus 1-1/2 threads, nor have less than 1-1/2 threads minimum projection. (Ref. (j), par. D-17f.)
8. Lifting bolts should be provided to facilitate hoisting and lowering of the equipment. (Ref. (l), par. 3.15.)
9. Pliable washers should be used with mounting bolts for glass face plate of the Azimuth Range Indicator. (Ref. (j), par. D-17o(2).)
10. Accessibility of the console bearing repeater dials and dial lights should be improved. (Ref. (j), par. D-2a (1).)
11. Tube clamps should be so positioned that they can readily be engaged or disengaged without the use of a tool. (Ref. (j), par. D-14.)
12. Holding clamp spade lugs should be secured by two rivets or two spot welds, not one. (Ref. (j), par. D-17i.)
13. Materials which support moisture penetration and fungus growth, or are flammable, should not be used. (Ref. (j), par. C-2c.)
14. The indicator panel of the console should contain the RCG-TVG" On-Off switch. (Ref. (f), par. E-26b.)
15. All inter-connecting terminal blocks should have 20 percent spare terminals. (Ref. (f), par. E-14.)
16. Wiring should be arranged in a neat and workmanlike manner. Where feasible, the wiring should be cabled and properly secured. (Ref. (j), par. D-11b(2).)
17. Conductor shielding should be properly grounded.
18. No solder connection should terminate more than three leads. (Ref. (j), par. D-12b.)
19. All component parts should be correctly symbol designated. (Ref. (j), par. D-24b.)

20. Function name plate or legible marking should be displayed adjacent to the control, switch, or handwheel. (Ref. (j), par. D-16L.)
21. Circuit symbols should be clearly marked or stamped with smudge-proof ink or dye. Markings should not be obscured by other components. (Ref. (j), par. D-24b(2).)
22. Transformers and chokes should be marked with manufacturer's name or symbol, the JAN type designation, rating, voltage, inductance, etc. (Ref. (k), par. E-22.)
23. Capacitors should be of the type and value specified in ref. (k), par. E-4.
24. Resistors should be of the type and value specified in ref. (k), par. E-18.
25. Cable connectors should be of the type specified in ref. (k), par. E-5.
26. Vacuum tubes should be selected from types listed in the Preferred List. (Ref. (k), par. E-23.)
27. Spare part components should be of the correct value and type for all units. (Ref. (f), par. E-2d.)
28. Errors in wiring prints and in the text and diagrams in the instruction books should be corrected. Missing portions of instruction books should be supplied.
29. The mechanical cursor on the SSI raster is not necessary and should be removed.
30. The driver high voltage interlock should be made positive acting and reliable.
31. The hinged cover plates on the remote PPI and SSI units should be made to open sufficiently to permit easy visual access to the controls.

B. Electrical

1. The pulse generator in the console should be made to operate with all associated switches connected in the circuit.
2. The pulse generator should be made to have more stable operation.
3. The amount of expand on the PPI CRT spiral expand should be made more stable.
4. The driver bias capacitor C-804 should be of higher voltage rating.
5. The first oscillator in the scanning receiver should be made to operate without parasitic oscillations when its tuning reactance is "on".
6. The SSI vertical sweep should be made more linear and the distance presented on the raster should be 600 yards when the equipment is under the control of the OKA recorder.
7. The second oscillator tuning reactance in the scanning receiver should be made to operate from a signal received by the listening receiver and not from the noise produced by the change from transmit time operation to receive time operation.
8. The frequency vernier control located on the console should be made to control the frequency of the first oscillator by the amount and in the direction as indicated on the frequency vernier dial.
9. The power supply unit in the amplifier-commutator assembly should be made to supply the scanning field amplifier with the correct plate supply voltage.
10. The 100-volt regulated power supply in the receiver-storage scanner should be made to regulate its output voltage within ± 1 percent when the line voltage is varied ± 10 percent.

11. The pass bands of the individual storage amplifier units should be made to be approximately 6 db down at 24.5 kc and 26.5 kc.
12. The noise level at the output of several of the individual storage amplifier units should be made 0.5 volts or less.
13. The AVC regulation of the individual storage amplifier units should be made to regulate the output levels so that they will be within \pm 0.5 db of the average of all the amplifier units over the input range of 100 microvolts to 1 volt. Also, for an input of 40 microvolts, the outputs of all amplifiers should be made to be alike within \pm 1 db.
14. The storage network and AVC in each of the individual storage amplifier units should be made to discriminate against pulses of shorter duration than 35 milliseconds, and the discrimination against pulses of longer duration than 35 milliseconds should be improved.
15. The transducer individual stave sensitivities should be made to be within \pm 2 db of the mean.
16. The transducer stave impedances should be made to be within \pm 10 percent of the mean.
17. The electrical phase angles of the transducer staves should be made to be within \pm 3 degrees of the mean.
18. The sound radiation pattern of the transducer should be improved at the larger depression angles when operating under MCC conditions, and the nullification of the beam in the horizontal plane should be improved.
19. The average of the main lobe transmitting response of the MCC section should be made at least 9.6 db higher.
20. The transducer efficiency should be increased by eleven percent.
21. The transmitting directivity index of the transducer should be improved by 2.8 db.
22. The sound radiation pattern of the main lobe in the horizontal plane of the standard section of the transducer should be made to be within \pm 2 db of the mean.

- [REDACTED]
23. The amplitude of the side lobes of the sound radiation pattern of the transducer in the vertical plane should be made to be - 10 db from the main lobe.
24. The average transmitting response of the standard section of the transducer should be made at least 6.8 db higher.
25. The open circuit receiving response of the transducer standard section, all staves connected in parallel aiding, should be made to be within \pm 2 db of the mean.
26. The sound radiation pattern produced by the MCC operation should be made to deflect downward instead of upward.
27. The angular horizontal receiving beam width of the transducer when associated with the commutator tubes and the lag lines should be made 17 degrees and the side lobes made to be down 18 db from the main beam maximum.
28. The horizontal receiving beam pattern of the transducer when associated with the lag lines should have a directivity index of 28 db.

C. Temperature and Humidity

1. Mechanical

a. Temperature test:

The equipment met specifications under conditions of the temperature test.

b. Humidity test:

All metal parts should be suitably protected against rust and corrosion. Lack of this protection resulted in corrosion of all hardware and the chassis of the SSI receiver. Improper preparation and preservation resulted in rust at the majority of the welds, in and around holes and cut-outs of the main framing, on the top covers of numerous transformer and other metal cases, and on some of the hardware such as brackets, Allen wrenches, etc.

2. Electrical

a. Temperature:

- 1) The 90-cycle Wein bridge oscillator in the console should be made to have more stable operation at low and high temperatures.
- 2) The spiral expand for the PPI CRT should be made more stable with respect to the amount of expand.
- 3) The stern mark cursor circuit in the console should be made more stable with respect to the phase between the stern mark cursor signal and the PPI spiral signal.
- 4) The ultrasonic operating frequency in the scanning receiver should be made to have less than 52 cycles variation over a period of an hour with a 10-degree temperature change, with the tuning reactances either off or on.
- 5) The 100-volt regulated supply of the receiver storage scanner should be made to regulate properly under conditions of low temperatures.

b. Humidity:

- 1) The keying circuit should be made to operate.
- 2) The spiral expand in the console should be made to operate.
- 3) The 225-volt regulated supply in the console should be made to regulate.
- 4) The 330-volt regulated supply in the console should be made to regulate.
- 5) The first ultrasonic oscillator in the scanning receiver should be made more stable with respect to frequency of oscillation whether the tuning reactance is off or on.
- 6) The second oscillator in the scanning receiver should be made more stable with respect to the frequency of oscillation when operating during transmission time.

- 7) The test set should be made to give correct meter indications.
- 8) The deflection amplifier in the amplifier assembly should be made to produce a spiral without noise and distortion.
- 9) The regulated 100-volt supply in the receiver storage scanner should be made to regulate within ± 1 percent.
- 10) The storage amplifiers and the receiver storage scanner brightening amplifier should be made to operate.
- 11) The 300-volt regulated supply in the receiver storage scanner should be made to regulate within ± 1 percent.

III. DESCRIPTION

A. General

The Model QHD Scanning Sonar Echo Ranging and Listening Equipment is designed for operation aboard naval vessels of types similar to the DD-692 class destroyers. Its primary purpose is to give a PPI (plan position indication) display of the surrounding underwater objects. This is accomplished by emitting short pulses of ultrasonic power in all directions and rapidly scanning (electronically) the underwater sound horizon for echo-producing targets. The equipment is also designed to be used for determining the range and bearing of specified targets for the attack sonar or for fire control use. Reception along any fixed line of bearing for an SSI (sector scan indication) and aural presentation is provided for by an auxiliary receiving channel. A servo system permits selection of any receiving sector desired. The equipment may also be used purely as a device continuously alert to ultrasonic sound from all bearings. It may also be used for communication by telegraphic code. A sound range recorder may also be operated from the equipment.

A field change modification for "Storage Scanning" is included. The purpose of the storage feature is to utilize all the sound energy inherent in echoes returning to the QHD equipment, and to prevent the loss of the echo energy occasioned by time-sharing of the scanning beam over all azimuthal bearings.

B. Major Units and Accessories

1. Console Assembly, Type C-706/SQS. (See Fig. 58.)

The console comprises five units. The Indicator-Control unit contains the PPI and SSI tubes, the training portion of the servo system and various controls and indicator lights associated with the display tubes and training system. The PPI tube displays a two-dimensional polar plot of all echo-producing objects in the area surrounding the ship, either in relative or in true bearing as desired. The SSI tube displays a two-dimensional rectangular plot of a selected sector of the PPI presentation.

The Sweep Generator Unit contains many of the system timing circuits, system controls and indicators. It includes the Range Sweep Circuit and the Oscillator Circuit, whose output is used for the rotating part of the PPI spiral sweep, for the rotations of the scanning beam, and for the cursor generating circuits. The Expander Circuit, the SSI Horizontal Sweep Circuit, the SSI Vertical Sweep Amplifier, the Gated Sweep Circuit, the SSI Brightening Circuit, the Rotation Booster Amplifiers, the Spiral Booster Amplifiers, the Rotation Phasing Units, and the Spiral Phasing Units are also parts of the Sweep Generator Unit.

The Timing Unit contains keying and timing circuits for the system. It consists of the Keying Circuit, the Blanking Circuit, The SQG-1 Compensator-Amplifier, the QHD Compensator-Amplifier, the Stern Compensator-Amplifier, the Stern Mark Pip Generator, Range Mark Right and Left Pip Generators, the SQG-1 Bearing Mark Pip Generator, the QHD Bearing Mark Pip Generator, the SQG-1 Bearing Mark Gate, the QHD Bearing Mark Gate, the Range Mark Gate, the Stern Mark Gate, the Cursor Mixer-Clipper, the Brightening Amplifier, and the Voltage Regulator.

The High-Voltage Power supply contains a dual high-voltage r-f power supply for the PPI and SSI tubes.

The Low-Voltage Power Supply contains a three-section power supply providing dc for the other units of the console.

2. Receiver Assembly, Type R-354/SQS. (See Fig. 61.)

This assembly consists of a Scanning Receiver, a Listening Receiver, an SSI Receiver, Test Set Unit, and a Power Supply for the included units.

The Scanning Receiver acts as a receiver for the scanning echo signals during reception, and as the signal generator for the transmitted signal during transmission. The receiver portion consists of one stage of r-f amplification, a crystal-type mixer, a two-stage narrow bandpass i-f amplifier, a broad bandpass i-f amplifier, an infinite impedance detector, and a cathode-follower output stage. The transmitting portion of the receiver consists of the first oscillator, the second oscillator, the driver signal mixer, the signal amplifier, the signal follower, and the signal output tube.

The Listening Receiver is a superheterodyne-type receiver which amplifies the listening echo signals and converts them to 500 cps. It consists of a stage of r-f amplification, a crystal mixer, two i-f stages, a second mixer, three audio stages, an RCG and TVG circuit, an ODN circuit, a discriminator rectifier, a paraphase amplifier, and a full wave rectifier for enhancing.

The SSI Receiver is a dual-channel receiver. Each channel consists of one stage of r-f amplification, a mixer, a limiter, three class A i-f stages (each followed by a limiter), a differentiating network, an amplifier stage, a cathode follower, and a blocking oscillator. The output pips from the left channel control the SSI brightening circuit and the output pips from the right channel trigger the horizontal SSI sweep circuit. The phasing of these output pips controls the brightening and sweep circuits of the SSI scope for sector scan indication of the target.

The Test Set consists of a vacuum-tube voltmeter, an amplifier, test switches, and a power supply. It is designed to indicate whether signal transmissions have occurred and their relative magnitude. It is also designed to indicate proper operation of the signal generation circuit, and in conjunction with the PPI display, to indicate length of signal transmission.

The Power Supply provides regulated and unregulated d-c and unregulated a-c for other units in the Receiver Assembly.

3. Amplifier-Commutator Assembly, Type AM-392/SQS. (See Fig. 64.)

This assembly comprises the Scanning Commutator which consists of a special (Type QK-255) radial beam tube. The radial beam tube consists of a cylindrical cathode, a cylindrical array of 48 grids, a cylindrical shield and a cylindrical plate. Rotating-field coils, which surround the tube, form the electrons emitted by the cathode into a radial beam. The output of the radial beam tube is the scanning signal obtained by the scanning of the 48 grids by the rotating beam.

The Listening Commutator consists of two radial beam tubes, and two beam forming and rotating magnets which are positioned by an appropriate servo mechanism. The 48 grids of the right radial beam tube receive signals from the 48 right halves of the receiving beams, and the 48 grids of the left radial beam tube receive signals from the 48 left halves of the receiving beam. The servo mechanism positions the magnets according to information from the servo system, and thus the output of the radial beam tubes consists of signals from the receiving beam selected by the servo system. These signals, after amplification, are applied to their corresponding channels of the SSI Receiver.

The Scanning Field Amplifier is a two-channel amplifier, each consisting of a four-stage audio amplifier. One channel amplifies the north-south rotation signal from the PPI stabilization resolver, the other amplifies the east-west rotation signal from the same unit. The outputs of this amplifier are applied to respective phases of the rotation coils in the Scanning Commutator.

The Coupling Amplifier is a three-channel amplifier, each channel consisting of a two-stage r-f amplifier. One channel amplifies the scanning signal from the Scanning Commutator, another amplifies the right half of the listening signal from the right radial beam tube in the Listening Commutator, and the third amplifies the left half of the listening signal from the left radial beam tube in the Listening Commutator. The output of the scanning channel is applied to the Scanning Receiver, while the outputs of the right and left listening channel are applied to corresponding channels of the SSI Receiver.

The preamplifiers are in eight units, each unit containing six identical preamplifier channels, or 48 channels in all. These are two-stage, fixed-tuned r-f amplifiers. Each channel receives the output from one stave of the standard section of the transducer, amplifies it, and applies it to the corresponding lag line of the lens network.

[REDACTED]

4. Servo Amplifier Assembly, Type AM-393/SQS. (See Fig. 67.)

This assembly contains the major portion of the servo system. It comprises the following items:

- a. Servo Unit which contains the synchros, servo motors and generators, resolvers and gears.
- b. Servo Amplifier Assembly which contains the following amplifiers for the servo system: the training servo amplifier, the listening commutator servo amplifier, the PPI stabilization servo amplifier, the true-relative servo amplifier, and the deflection amplifier. The latter is a two-channel audio amplifier which amplifies the spiral deflection signals for the PPI.

5. Sonar Driver-Amplifier, Type AM-394/SQS. (See Fig. 69.)

This is essentially a two-stage, push-pull amplifier. (Two type 3X2500F3's as final power amplifiers, driven by a pair of type 715 C's). It receives the excitation signal from the signal-generating portion of the Scanning Receiver, amplifies it to about 40 kw at full power and applies it to the transducer through the transmit-receive transfer relay circuit. The unit also contains various a-c power-distributing and interlocking circuits for the system.

6. Transducer, Type CRP-51117-A. (See Fig. 71.)

This unit is designed for transmission and reception of ultra-sonic frequencies (26 kc). It is cylindrical in shape, the side surface being a sound-transparent rubber diaphragm. It is 22-5/8 inches high and 19 inches in diameter, and weighs 880 pounds. The mounting is designed for attachment to a standard type QC hoist mechanism; training of the unit is not required. The unit is of magnetostrictive type, consisting of stacks of nickel laminations, magnets, and coils arranged cylindrically in vertical staves to provide omnidirectional characteristics in the horizontal plane. An MCC section is provided for depressing the transmitted beam in order to detect targets at close range.

[REDACTED]

7. Power Transformer, Type CRP-301223. (See Fig. 72.)

Two transformers are connected to the 3-phase 440-volt supply in an open delta system and provide 3-phase 110-volt supply for the equipment. A 78-volt supply may also be obtained from these units, but is not used.

8. Motor-Generator Assembly, Type PU-200/U. (See Fig. 73.)

This unit consists of two dc generators, an ac motor, and an exciter, all mounted on one frame and mechanically coupled together. The motor draws 440-volt 3-phase power from the ship's supply. The exciter produces 440 volts dc for the fields of the generators and for the bias supply of the driver-amplifier. The generators each produce 2800 volts dc, and their outputs are connected in series to supply 5600 volts dc to the driver-amplifier.

9. Motor Starter, Type CAE 211981. (See Fig. 74.)

This unit controls the starting and stopping of the ac motor in the M/G assembly.

10. Relay Assembly, Type RE-84/SQS. (See Fig. 76.)

This unit controls the voltage output and dynamic braking of the generators in the M/G assembly. It also contains the high-voltage fuses and the combination r-f bypass and storage capacitors.

11. Receiver-Storage Scanner Assembly, Type R-522/SQS. (See Fig. 78.)

This assembly contains 49 Storage Amplifiers (48 active, 1 spare), a Scanning Commutator (Type QK-255 radial beam tube), a Brightening Amplifier unit and a regulated Power Supply. Each storage amplifier unit is a three-stage r-f amplifier with a bandpass of approximately 2 kc centered at 25.5 kc; the output is dual channel. The Receiver-Storage Scanner Commutator tube and brightening amplifier replaces the Scanning Commutator tube in the Amplifier-Commutator Assembly when the system is switched to "Storage" operation.

12. Loudspeaker Unit, Type LS-168/U. (See Fig. 80.)

Each of the four speaker units contains an "on-off" switch and a step attenuator control.

13. PPI Aximuth Range Indicator, Type IP-95/SQS. (See Fig. 81.)

The three units supplied are identical and contain a PPI tube, an amplifier for the brightening signal, a regulated low-voltage power supply, an r-f type high-voltage power supply, deflection coils, and various controls for the PPI tube. These units receive the brightening signals from the Scanning Receiver and cursor generators, and the two-phase spiral deflection signals from the Deflection Amplifier, and produce a display identical with the PPI display on the console.

14. SSI Aximuth-Range Indicator, Type IP-96/SQS. (See Fig. 83.)

This unit contains an SSI tube, together with an SSI horizontal sweep circuit, an SSI vertical sweep circuit, and an SSI brightening circuit which are practically identical with corresponding circuits in the Sweep Generator. It also contains an r-f type high-voltage power supply, a dual low-voltage power supply, and various controls for the SSI tube. The unit receives the right and left pulses from the SSI Receiver as well as the enhancing and range-sweep signals from the Sweep Generator, and produces a display identical with the SSI display on the Console.

15. Headset Assembly, Type CRP-49621.

Two headset assemblies supplied are used for listening in place of the loudspeakers.

16. Operator's Chair, Type CRP 10691. (See Fig. 85.)

The chair is especially designed for the operator's comfort and convenience.

IV. INSPECTION, TESTS, AND RESULTS**A. General — All Units and Accessories****1. Gross weight and dimensions of crated units:**

Box No. and description	Weight (lbs.)	Height (in.)	Width (in.)	Depth (in.)
#1-Console	858	55-1/2	29	33-3/4
#2-Receiver Assembly	782	78-1/2	27-3/4	24
#3-Amplifier Commutator	1252	78-1/2	27-1/2	29
#4-Amplifier Assembly	605	66	25-1/2	28-1/4
#5-Driver Amplifier	630	66-1/2	27-3/4	32
#6-Transducer	1140	28-1/2	31-1/2	33-1/4
#7-Transformer	112	14	16-1/2	18
#8-Transformer	113	14	16-1/2	18
#9-Motor-Gen. Assembly	1900	27-1/2	27	97-3/4
#10-Motor Starter	47	14-1/2	18-3/4	28
#11-Relay Assembly	305	35-1/4	30-1/2	23-7/8
#12 to 15-Loud-speakers (50)	200	14-1/2	18-3/4	28
#16-Chair	110	24-1/4	24	36
#17 to 19-Remote PPI (184)	552	20-1/2	23-1/2	31
#20-Remote SSI	227	20	31-1/2	33-1/4
#21-Cable	80	8-3/4	29	30-1/4
#22-Spare Box 1	137	14-1/2	29-1/2	19

Box No. and description	Weight (lbs.)	Height (in.)	Width (in.)	Depth (in.)
#23-Spare Box 2	119	14-1/2	29-1/2	19
#24-Spare Box 3	119	14-1/2	29-1/2	19
#25-Spare Box 4	165	14-1/2	29-1/2	19
#26-Spare Box 5	165	14-1/2	29-1/2	19
#27-Spare Box 6	125	14-1/2	29-1/2	19
#28-Spare Tubes	118	24-1/2	24-1/4	36-1/4
#29-Spare Tubes	102	24-1/2	24-1/4	36-1/4
#30-Spare Tubes	58	17-3/4	17-1/2	32
#31-Spare Tubes	58	17-3/4	17-1/2	32
Second shipment:				
#1-Storage Scanner Unit	1073	79-1/2	25-5/8	27-1/4
Third shipment:				
#1-Spare Box 1	166	14-1/2	29-1/2	19
#2-Spare Box 2	132	14-1/2	29-1/2	19
Total Gross Weight . . .	11,450			

2. Weight and dimensions of units uncrated. Dimensions are overall (include shock-mounts but not mounting strips). Relay unit was not supplied with shock-mounts.

Unit	Weight (lbs)	Height (in.)	Width (in.)	Depth (in.)
Console Assembly C-706/SQS	653	48	22-5/16	27-15/16
Receiver Assembly R-354/SQS	615	71-13/16	21-1/2	18-1/16
Amplifier Comm. Assembly AM-392/SQS (including Scanning storage switch box) Without switchbox Switchbox only	1070	71-13/16 71-13/16 38-1/4	23-5/8 21-3/8 23-5/8	20-13/16 19 5-1/8
Servo Amplifier Assembly AM-393/SQS	437	58-1/2	23-1/2	18-3/16
Driver Amplifier Assembly AM-394/SQS	465	58-13/16	21-5/8	17-15/16
Transducer CRP-51117A	880	22-5/8	19 diameter.	
Power Transformers CRP-301223 (two) (90)	180	11-3/4	11-1/8	10-5/8
Motor-generator Assembly PU-200/U	1804	19-1/2	21-1/2	90-7/8
Motor-starter CAE-211981	25	14-15/16	9	8-1/4
Relay Assembly RE-84/SQS	212	25-3/4 less shock mounts	25	16-1/4 less shock mounts
Receiver Storage Scanner Assembly R-522/SQS	868	71-7/8	21-5/8	20-9/16
Loudspeaker LS-168/U (four-29 lb. each)	116	18-1/16	14-1/4	10-5/8

Unit	Weight (lbs.)	Height (in.)	Width (in.)	Depth (in.)
Operators Chair	61	18 min. 26 max.	22-1/2	16-1/2
Azimuth Range Indicator-PPI IP-95/SQS (three 128 lb. each)	384	18-5/8	11	17-5/8
Azimuth Range Indicator-SSI IP-96/SQS	138	18-9/16	10-5/16	20-1/2
Spare Parts Box 1	105	12-1/2	25	16-5/8
Spare Parts Box 2	85	12-1/2	25	16-5/8
Spare Parts Box 3	88	12-1/2	25	16-5/8
Spare Parts Box 4	133	12-1/2	25	16-5/8
Spare Parts Box 5	136	12-1/2	25	16-5/8
Spare Parts Box 6	93	12-1/2	25	16-5/8
Miscellaneous Headphones-tubes packed in card- board containers	120			
Field Change Spare parts box 1	139	12-1/2	25	16-5/8
Spare parts box 2	100	12-1/2	25	16-5/8
Total weight of system	8,907			

3. Shipping containers were of proper construction for domestic shipment.
4. Two sets of installation prints originally supplied were found to be not up-to-date. Corrected prints were later supplied.
5. Two instruction books (in manuscript form) were supplied. Errors noted in text and in diagrams were:

Page 1-6 and 1-7, par. (f) and (i) are same subject.
Page 1-14, par. (7), third line, should read ac instead of dc.
Page 1-18, par. (f), Transducer CRP-5117A, should read CRP-51117A.
Page 1-22, third par. V-3113, a 6V6GT, should read V-3113, a 6L6WGA.
Page 1-23, third par., C-1101, C-1148, should read C-1901, C-1948 (occurs twice)
Page 1-35, par. (c), V-3305A, should read V-3305B. Also, in Fig. 4-9, V-3305 should be designated as V-3305A and V-3305B.
Page 1-50, fifth par. GGT should read GTT.
Page 1-51, par. (c), G-4405 and B-4406, should read G-4405 and G-4406.
Page 1-61. Tube types listed were not in full agreement with types used in equipment. Examples: 6AL5 instead of 6AL5W, 5U4WG instead of 5U4WGA.
Page 2-5, par. (2); terminal 4, 5 and 6 of terminal strip E-801 are not correct as the terminals mentioned are not connected or used.
Page 2-5, par. (2), lines twelve and nineteen; terminals 2A-50 and 2A-51 of terminal strip E-801 should read terminals 50 and 51 of terminal strip E-806.
Page 2-5, par. (c) line 25; terminals 1A-120 and 1A-122 should read terminals 120 and 122.
Page 2-6, first par. line 3; 2A-22 and 2A-28 should read 22 and 28.
Fig. 1-20; tube V-801 was a type 715-C, not a type 3C24. Block marked T-801 should be marked T-805.
Fig. 1-22. Exciter connections are not in agreement with those of the generator.
Fig. 1-23; C-907 to C-1942 should read C-1907 to C-1942.
Fig. 1-33. Tube V-3310B was shown in two circuits; should be designated as V-3310A and V-3310B. Z-3301 was designated as Z-2301.
Fig. 1-35. Resolver G-4202 windings were not marked in proper sequence.
Fig. 1-27. Tube V-2102 should be type 7BP7A.
Fig. 4-4. Resistor R-2334 was 110 K instead of 150 K as shown.
Fig. 4-8. Connection to pins 4 and 6 of V-3115 were actually the reverse of those shown on diagram.
Fig. 4-10. Connections to Z-3501, Z-3503, Z-3504 and Z-3506 were not as shown on print. Terminals 1 and 2 were reversed and 3 and 4 were reversed in all cases.
Fig. 4-10. V-3515 tube type marked on chassis did not agree with type shown on print.
Fig. 4-11 and 4-13. Terminal board E-3803 on print was marked as E-3805 on chassis.
Fig. 4-17. Resistors R-1617 and R-1618 were shown on print as 330 ohms, but resistors in circuit were 1,000 ohms. Resistor R-1614 shown on print as 27 K ohms was 2.7K ohms in circuit.

Fig. 4-24. V-204, type 6AS7 should read 6AS7G.

Fig. 4-30. Exciter wiring connections were not as shown.
F1+ instead of F2- connected to A1-.

Print number 60896 showed one generator as type AN/G32U
and the other as AN/G33U, but both were type AN/G33U. The
exciter should be designated as AN/G32U.

6. Two instruction books (in manuscript form) for the QHD Storage Scanning modification were supplied. Errors found in text and in diagrams were:

Page 1-16, par. 4, line 5, 6AL6 tube type should read 6AL5.

Table 1-3. Tube type listed as 6A57 should read 6AS7G.
Table referred to types 6SJ7 and EL-C3J/A, but spare parts list referred to same tubes as 6SJ7W and C3J/A.

Figs. 1-13, 1-16, 2-1, 2-2, 2-3, 2-4 and 4-1 were missing from instruction book. Installation type prints were supplied for these missing diagrams. Print number 61391 showed terminal number 9 on E-1901; this terminal should be number 19.

Sheet 30, item R-4303. JAN type designation was incorrect; should be RC30BF394K.

Sheet 5, item A-4110 was listed incorrectly as A-410.
Parts list lacked all C-4200 series items.

7. One major unit, the Relay Assembly, was in addition to the units required by ref. (f) par. E-24.
8. Nameplates were properly mounted on all units.
9. Spare parts were in accordance with specifications, except for the Driver-Amplifier spares which were, in general, of the wrong values. Modification of this unit after assembly of spare parts accounted for this discrepancy.
10. Material and workmanship, with some few exceptions, were good.
11. Blower motors and/or ventilation louvers were provided on all except the Relay Assembly, the SSI, and PPI remote units.
12. Accessibility in general was good; exceptions were as noted in the individual unit inspection report. Channel-guided or pivot construction was usually used wherever possible.
13. Fungus and moistureproofing of component parts was not required by specifications. The material used, except for the cardboard framing of the blower motor dust filters, appeared to be of a type that would not support fungus growth or absorb moisture.
14. Moving parts. Adequate means have been provided to protect personnel from moving parts.

15. Special tools (e.g. Allen wrenches) in suitable holders were provided where needed in the equipment.
16. Controls in general were properly arranged and housed. Handles, knobs, etc., were of approved material and properly secured to shafts.
17. Terminal strips in several instances had less than the required number of spare terminals.
18. Telephone jacks suitable for sound-powered phones were provided on all except the Relay Assembly and the Receiver-Storage Scanner assembly.
19. Space heaters were provided in the Console and the Receiver-Storage Scanner assemblies. They were energized when the equipment was de-energized.
20. 115-volt ac service outlets were provided on all except the Relay Assembly and the Receiver-Storage Scanner Assemblies.
21. The motor generator unit was equipped with permanently greased and sealed bearings.
22. Safety to personnel. The protective interlock and discharge circuit used in the driver high voltage supply was not reliable and positive acting. However, a suitable discharge probe was provided. Interlocks on all other units operated satisfactorily when any front cover, or the top cover of the Console unit, were removed.
23. With the equipment de-energized, 115-volt "power available" remained on all units. Suitable "power available" warning lights were provided.
24. Ground potential. All power supplies were tied to a common ground.
25. Suitable test points were provided in the equipment. High voltage test points were less than 1,000 volts potential.
26. Fuses were provided in the event of an overload. Blown fuse indicators were provided for the majority of the fuses.
27. Power requirements from the 3-phase, 440-volt supply was approximately a balanced load. Current required by the system under various operating conditions with the line voltage set at 440 volts was as follows:

<u>QHD Operating Conditions</u>	Amperes Phase		
	A	B	C
Full Power - Receive Time, max.	9.2	11.4	10.6
Full Power - Transmit Time, max.	13.6	16.8	15.2
-10 db during Receive Time	6.5	9.0	8.3
Locked-key operation	10.0	12.0	11.9
All equipment operating except the m/g	2.5	4.2	3.8
M/G set starting	37.5	37.5	37.5

28. The average power required during the full power operation with the pulse repetition rate as rapid as possible (one pulse every 1.265 seconds) and pulse length as long as possible (33 milliseconds) was approximately 7,640 watts.
29. The power factor with the equipment fully energized and pulsed under the most severe conditions was 0.955.
30. The operator's chair was suitably constructed and was adjustable for height. The back rest was also adjustable.
31. Vacuum tubes. Reference (f) par. E-30a, granted waiver for special tube type R-2059-T. Special tube type used (radial beam tube) was a QK-255. There were thirty-three other type tubes used in the system, 34 percent of which were listed in the Preferred Parts List (PPL), 51 percent were not on the PPL but were listed in the Qualified Parts List (QPL), and 15 percent were not on either list.

B. Mechanical - Individual Units.

1. Console Assembly C-706/SQS:

- a. Six standoff insulators for high voltage leads in power supply were loose.
- b. Threads were stripped on hold-down bolts for top cover of high-voltage power supply chassis.
- c. Threaded portion of spade lugs of condenser holding clamps in numerous cases were too long. Examples: C-2708, C-2753, C-2754, and C-2755.
- d. Readability of function designation markings on mounting board containing the PPI gating, range mark, spiral balance controls, etc., was very poor. Ink color too nearly matched color of the mounting board.

- e. Function name plates were missing for the hand key, training handwheel, and SSI cursor knob.
- f. Symbol designations were missing for C-2317, G-2101, R-2103, R-2333, R-2334, R-2335, R-2465, R-2467, S-2110, S-2113, S-2704, V-2304, and TP-2304.
- g. Circuit diagram showing working voltage, current rating, etc., was missing on L-2701.
- h. Symbol designation for L-2701 was hidden by resistor terminal board.
- i. Leads were too long on the mounting board located at the lower center of the timing unit; same applies to stator leads of C-2353 and C-2356.
- j. Some leads were not properly secured or cabled (lead to coil of K-2701, leads on right mounting board of timing unit, leads to E-2204 and E-2205).
- k. In several cases, more than three connections were made to one terminal pin (R-2843, R-2875, R-2876, and R-2877 connections went to a common terminal pin).
- l. Capacitors C-2270, C-2271, C-2272, C-2273, C-2288, and C-2289 were not JAN type.
- m. Resistor R-2284 was not JAN value.
- n. Terminal designation marking of conductor sleeving was blurred and unreadable.
- o. Lower right front hinged control panel was not provided with a catch for holding panel in the maintenance position.
- p. Cardboard and paper frame of dust filter was flammable and moisture absorbent, and would support fungus growth.
- q. To electrically zero the bearing repeater synchros it was necessary to remove the synchro housing casting. This required the removal of four dial lights, of four screws from the face of the casting, and of eight screws from glass plate retainer, plus ten electrical connections from the synchros. Zeroing of B-2102 and B-2103 could have been more easily accomplished if the dial face plate had been removable.
- r. The holding screws of the timing unit back cover plate were poorly positioned. Upper screw could short R-2853, R-2854, and R-2855 to ground. Second screw could damage R-2876. Third screw could ground R-2741. Fourth screw could damage R-2755.

- [REDACTED]
 - s. Dial lights I-2101 to 2104 on "true-relative indicator" were not easily accessible.
 - t. Vacuum tubes V-2308, V-2711, V-2728, V-2730 type 6SJ7W, V-2315 and V-2322 type 6SN7W were not types listed in PPL or QPL.
 - u. Console main terminal board was poorly designed from viewpoint of accessibility for servicing and the location and clearance of cable entrance openings.
 - v. Lifting bolt holes were at each top corner of the assembly but lifting bolts were not furnished. The tapped holes were not properly labeled "Lift Here".
 - w. The console indicator panel was sloped approximately 30 degrees from the vertical.
 - x. The indicator panel contained all switches and controls required by ref. (f) para. E-26b, except the following:
 - a. Synchro Input selector switch was mounted on lower instrument panel of the console.
 - b. TVG, RCG On-Off switches were not located on the console but were located in the scanning receiver.
 - y. Although there were a large number of operating controls, the number was kept to a minimum consistent with proper operation of the equipment.
 - z. All frequently adjusted controls and test switches were located behind suitable covers. Semi-fixed and other control switches were conveniently mounted on the chassis. A hand telegraph key was properly mounted on the right side of the console.
2. Receiver Assembly R-354/SQS
- a. Front brackets, for receiver chassis cover plate securing screws, were too close to the front panel. Screws were not easily removed and front panel rubber gasket could have been damaged when the screws were removed.
 - b. Power supply chassis was mounted on rollers and slides and no provisions were made for tilting of chassis to facilitate servicing. Bottom of chassis was approximately 12 inches above the deck, making access to terminal connections of component parts extremely difficult.
 - c. Terminal designation markings of conductor sleeving were blurred and practically unreadable.

- d. Numerous bolts were too long. Examples: Holding bolts for C-3109, C-3338, L-3102, L-3801, T-3105, T-3304, and Z-3104.
 - e. Vacuum tubes V-3115, V-3504, V-3506, V-3508, V-3515, V-3516, V-3517, V-3519 type 6SJ7W, and V-3107, V-3109, V-3110, V-3111, V-3114, V-3116, V-3304, V-3305, V-3309, V-3310, V-3503, V-3505, V-3507, V-3509, V-3511, V-3514, V-3518, V-3520, V-3522, V-3802, V-3803, V-3804, V-3805, V-3806 type 6SN7W, and V-3501 type 6SL7W were not types listed in PPL or QPL.
 - f. The scanning receiver wiring in general was not neat or properly cabled, and some wires were excessively long.
 - g. In the listening receiver a few wires were excessively long, uncabled, or not properly supported. Examples: From Z-3304 to T-3305; from R-3328 to binding post in center of chassis; cable from J-3303.
 - h. Type or symbol designation marking was missing for C-3328, R-3348, R-3708, and V-3113.
 - i. Markings showing circuit diagram, rating, working voltage, current, etc., were missing on T-3106 and T-3802.
 - j. Circuit diagram, rating, etc. of T-3302 were obscured by T-3303. T-3303 was so positioned that it's circuit diagram marking could not be read.
 - k. One swaging tool was found in wiring of test set.
 - l. The mounting bolts of the center terminal strip in the test set were too long.
 - m. There was only one rivet in each spade lug of holding clamps for C-3807.
 - n. R-3706 (3300-ohm) was not a JAN value.
 - o. Terminal boards E-3902 and E-3903 had less than 20 percent spare terminals.
 - p. Lifting bolt holes were at each top corner of the assembly but lifting bolts were not furnished. The tapped holes were not labeled "Lift Here".
3. Amplifier Commutator Assembly AM-392/SQS
- a. Height of Scanning Commutator Selector switchbox (attached to rear of Amplifier Commutator assembly) was 8-1/4 inches over the specification limit of 30 inches.

- b. Captive chassis holding bolts of the Scanning Field Amplifier did not firmly seat the unit when they were fully tightened.
- c. Numerous component mounting bolts were too long. Examples: C-1205, C-1601, C-1623, C-1624, C-1803, C-1806, C-1818, L-1601, L-1602 and T-1602.
- d. Terminal bolts of capacitor bank in storage switching unit were too long or too short in several instances. Examples: C-1921, too short; terminals 8B and 40B, too long.
- e. Connection to terminal 28 of E-1701 was not properly secured with a nut.
- f. Vacuum tubes V-1204, V-1206, V-1214 were types not listed in PPL or QPL.
- g. Tube clamp for V-1213 was improperly positioned for easy operation.
- h. Wires from pin 54 of V-1301, V-1302, and V-1701 to coupling amplifier were too short to allow chassis to be fully extended to its maintenance position.
- i. Wires to R-1641 and R-1642 were not tied down.
- j. Microswitch S-1104 mounting bolts were loose.
- k. Shielding was not grounded on two shielded wires to terminal board E-1110, and on four shielded wires to terminal board E-1102.
- l. Cable to terminal board E-1801 was too long and was improperly supported.
- m. Four condensers on E-1701 were not symbol-designated nor were they accessible.
- n. Majority of component parts of the preamplifiers were not symbol-designated.
- o. Sound power telephone receptacle was unmarked.
- p. Terminal boards E-1301 and E-1302 were so positioned as to make it extremely difficult to adjust synchros of the listening commutator.
- q. Cable connectors P and J-1101, 1102, 1103, and 1104 were not JAN types.

- r. Cardboard and paper frame of dust filter was flammable, moisture absorbent, and would support fungus growth.
- s. Terminal designation markings of conductor sleeveings were blurred and unreadable. Example: E-1601, G-1301, G-1302, G-1303, and G-1304.
- t. Terminal boards E-1105, E-1106, and E-1109 had less than 20 percent spare terminals. Wiring print showed E-1106 to have three spares; it actually had one. E-1108 was shown as having 45 terminals with 19 spares; actual terminals were 43 with 21 spares.
- u. The power supply chassis, from a maintenance viewpoint, was poorly engineered. The chassis was detachable but the cabling, terminal boards, etc., would not permit removal of unit without excessive unhooking of cables.
- v. Connecting plug block of preamplifier unit number 5 was not properly centered for correct mating of plug and receptacle.
- w. Tube type designation (OA2) was missing on V-1802.
- x. Lifting bolt holes were at each top corner of the assembly but lifting bolts were not furnished. The tapped holes were not properly labeled "Lift Here".

4. Servo Amplifier Assembly Am-393/SQS

- a. Nuts of holding screws for terminal boards E-4411, E-4412, E-4413, and E-4414 were not sweated to panel to facilitate servicing of synchros. These boards were so positioned that adjustment of synchros required removal of the mounting bolts.
- b. Numerous holding bolts in top chassis were too long. Examples: For C-4301, C-4303, C-4306, C-4312, C-4314, C-4315, C-4321, C-4325, and L-4303.
- c. R-4335 chassis mounting bracket was loose.
- d. G-4406 rear cover plate was loose.
- e. G-4204 nut was loose on ground wire connection.
- f. Stator body support flange for G-4404 was eccentric and would not allow for proper adjustment of the unit.
- g. Terminal boards E-4401, E-4402, E-4403, and E-4404 had less than the required 20 percent spare terminals. Wiring print showed E-4401, E-4402, and E-4403 to have 14 terminals; actually they each had 12 terminals

- h. Tube type-designation (6V6GT) was missing on chassis for V-4308.
 - i. Tube V-4101 was designated on chassis as V-1101.
 - j. Vacuum tube V-4103 type 6SJ7W, and V-4301, V-4304, V-4307, and V-4309 type 6SN7W were types not listed in PPL or QPL.
 - k. Lifting bolt holes were at each top corner of the assembly but lifting bolts were not furnished. The tapped holes were not properly labeled "Lift Here".
 - l. The casting into which the stator body flange of G-4404, a spare 5G 1X synchro, fits was eccentric and did not provide adequate seat for the synchro flange. The synchro unit could not be properly locked on electrical zero due to this defect in the casting.
5. Sonar Driver-Amplifier AM-394/SQS
- a. A mounting bolt was missing on terminal board E-806.
 - b. Sound power telephone receptacle was unmarked and lacked cap cover.
 - c. Terminal boards E-803, E-805, E-806, and E-808 had less than the required 20 percent spare terminals.
 - d. Vacuum tubes V-801, V-802 type 715-C, V-803, and V-804 type 3X2500F3 were types not listed in PPL or QPL.
 - e. Lifting bolt holes were at each top corner of the assembly but lifting bolts were not furnished. The tapped holes were not properly labeled "Lift Here".
6. Transducer, Type CRP-51117-A.
- a. The transducer met requirements for size, weight, and finish.
 - b. Twelve 3/4-inch studs suitably spaced in the mounting plate were provided for securing the unit to the bottom flange of a standard QC type training shaft.
 - c. The unit was so designed that it could be disassembled or repaired without the use of techniques or tools which are not ordinarily available in shops of a naval base.
 - d. All transducer leads were properly marked and suitably lugged for connection to terminal boards.

- e. Lead from segment 20 to the connector block was broken. Cause of break was apparently due to insufficient slack in lead. Repair was made by the contractor's representative.
 - f. Due to lack of laboratory facilities, the Impulse Shock Test and the Hydrostatic Pressure Tests were not performed.
 - g. Shock and Vibration Tests were not required. (Reference (a), par. 2.)
7. Power Transformer CRP 301223.
- No discrepancies were noted.
8. Motor-Generator Assembly PU-200/U
- a. Connections from the exciter were not as shown on print No. 61020. Al- and F1+ were common; print showed Al- and F2- as common.
 - b. Lead Al- from exciter was not labeled.
9. Motor Starter Type CAE 211981
- No discrepancies were noted.
10. Relay Assembly RE-84/SQS
- a. Terminal connection was loose on C-501 and on the -3400-volt terminal board.
 - b. Support for C-513 was loose.
 - c. Terminal board E-502 was not symbol designated and had less than the required number of spare terminals.
 - d. Unit was not shock mounted.
 - e. Very slight amount of oil seepage from the bottom of C-503 and C-504 appeared not to have affected the capacitors electrically.
11. Receiver-Storage Scanner R-522/SQS
- a. Mounting bolts of transformers and filter units and spade lugs of capacitor holding clamps were too long. (Applies to 49 storage amplifier units.)
 - b. Spade lug of holding clamp for C-4201 was too long.
 - c. Plate cap of V-4210 struck the bottom of the amplifier chassis when the power supply tube chassis was tilted forward to the maintenance position.

- d. Spare terminals were not provided on terminal boards E-4105, E-4106, E-4107, and E-4108.
 - e. Cardboard and paper frame of dust filters were flammable, moisture absorbent, and would support fungus growth.
 - f. Scan Gain potentiometer was incorrectly designated as R-4316 on rear of chassis.
 - g. Capacitor C-4409 is not JAN type.
 - h. Resistors R-4247, R-4248, R-4309, R-4311, R-4316 and R-4411 were not JAN type.
 - i. 110-volt ac utility outlet was not provided.
 - j. Sound power phone outlet was not provided.
 - k. Lifting bolt holes were at each top corner of the assembly but lifting bolts were not furnished. The tapped holes were not properly labeled, "Lift Here".
12. Loudspeaker LS-168/U (4 units)
- Height was 1/8 inch over the allowable 18 inches. Depth was 11/16 inch over the limit of 9-1/2 inches.
13. Azimuth Range Indicator (PPI) IP-95/SQS (3 units)
- a. Depth was 1/2 inch over the allowable limit of 17-1/2 inches.
 - b. Some leads were excessively long and were unsecured.
Examples: Pin 2 of X-204 to C-201, from C-201 to L-201, from R-203 to pin 2 of X-204, and from L-201 to X-204.
 - c. No circuit diagram, voltage rating, current rating, etc., were marked on T-201 and L-201.
 - d. Serial No. 1, CRT was out of its socket and tube shield was bent.
 - e. Serial Nos. 1 and 3, front cover plates for CRT were cracked at lower mounting screw hole.
 - f. Sound power telephone receptacle was unmarked on all three units.
 - g. Resistor R-284 (50 megohms) was not a JAN value.
 - h. Capacitors C-288 and C-289 were not JAN values.
 - i. Terminal board E-201 had less than the required 20 percent spare terminals

- j. V-201 tube type designation on chassis was 5U4WGA. Tube in unit was type 5U4G.
 - k. All necessary control knobs and switches were behind a hinged panel. However, this panel did not open far enough to permit easy visual access to the controls.
14. Azimuth Range Indicator (SSI) IP-96/SQS
- a. T-101 and T-102 were not marked with circuit diagram, voltage rating, current rating, etc.
 - b. Sound power telephone receptacle was unmarked.
 - c. R-101 and R-102 (7500 ohms) were not JAN value resistors.
 - d. C-170, C-171, C-172, and C-173 were not JAN value capacitors.
 - e. Vacuum tubes V-109 and V-118 type 6SN7W were not listed in the PPL or the QPL.
 - f. Terminal board E-101 had less than the required number of spare terminals. Wiring print showed it to be a 20-terminal board with 5 spare terminals, but it actually was a 17-terminal block with one spare.
 - g. All necessary control knobs and switches were behind a hinged panel. However, this panel did not open far enough to permit easy visual access to the controls.

C. Electrical - Individual Units:

1. Console Assembly, Type C-706/SQS
- a. The sonar indicator control console contained the minimum number of electronic components necessary for operation which may require servicing.
 - b. A mechanical cursor arrangement was provided on the SSI scope that permitted the operator to center horizontally the target pip on the SSI scope. The listening channel beam would then be centered on the target bearing. This control was cumbersome for the efficient operation of the equipment.
 - c. The synchro input selector switch selected either cBrq (generated relative sonar bearing) at 36X, Co (own ship's course) at 36X, or zero order to be applied to the training servo system.
 - d. The normal sweep circuits for the PPI and SSI were capable of being selected for 600, 2000, 4000, and 6000-yard range presentation. Small errors in actual range presentations were experienced as shown in table on the following page.

Specifications allowed 10 percent error.

Range Setting Yards	Actual Range Presented Yards	Percent Error
600	611	1.8
2000	2080	4.0
4000	3855	2.95
6000	6080	1.3

- e. A cursor, approximately one-half inch long, could be obtained on the outer edge of the PPI scope which repeated Brg (relative sonar bearing) as accepted from an attack sonar equipment. Another cursor approximately three quarters of an inch long, produced at the outer edge of the PPI scope, indicated the bearing of the directed listening beam of QHD. Both of these cursor lengths could be adjusted by controls in the Timer unit.
- f. The operator could cause to be printed two additional lines which straddle the bearing of the listening beam. They extended from the center of the scope to a range as determined by the range indicator control.
- g. In addition to the stabilized relative bearing presentation on the PPI scope, stabilized true bearing was also provided, the stabilization being supplied from a unit such as the Mk 23.
- h. Selection of either stabilized relative or stabilized true bearing presentation was available to the operator by means of True-Relative switch on the covered control panel.
- i. Provision was also made for printing a dotted line on the PPI scope to indicate the direction of the ship's stern when true bearing was being displayed. This feature in no way affected the sweep time or the normal functioning of the PPI scope presentation, and functioned only when the True-Relative switch was in the True position.
- j. True and Relative indicating lights and a Stabilization On light were provided on the console panel. The indicating lights were such that no objectionable glare or effects were present when the PPI and SSI scopes were viewed by the operator.
- k. In addition to the normal SSI sweep which was synchronized with the PPI sweep, the SSI sweep could be gated by either the QHD range control or an OKA-1 recorder or similar equipment. When the SSI was gated, the sweep rate was the same as the 600-yard rate regardless of PPI sweep rate. This feature provided a full scale on the SSI scope raster of 506

yards, 94 yards short of the correct 600-yard range. The sweep at the end of the raster deviates from linearity by about 8 percent (see Fig. 1).

1. When the SSI sweep was gated by the QHD range control, the sweep was initiated at the time that the listening beam cursors, on the PPI, ceased. Thus, in order to center an echo on the 600-yard SSI raster, the listening beam cursors had to be reduced in range presentation by 300 yards less than the target range.
- m. When the keying of the equipment was under the control of the OKA-1 recorder (or similar BuOrd equipment), the SSI scope automatically provided for range gating so that the target indication was centered vertically on the display.
- n. For target ranges of less than 300 yards, the operation of the SSI was not changed, which was considered to be normal operation.
- o. Range scale and keying repetition rates were selectable by the operator except when the keying becomes slaved to the OKA-1 recorder (or similar equipment), in which case the keying function was no longer under the control of the operator, except for scanning rates.
- p. The frequency of the Wien bridge oscillator controlling the transmitted pulse length and the scanning rate of the electronic scanning tube and PPI could be selected at approximately 30, 90 and 300 cycles.
- q. The 30-cycle scanning rate produced a transmitted pulse length of 33.3 milliseconds, the 90-cycle rate a 11.1-millisecond pulse, and the 300-cycle rate a 3.3-millisecond pulse.

These pulse lengths were referred to in the specifications and indicated on the pulse length selector switch as 35, 12 and 3 milliseconds respectively. Thus, these figures were used as an approximation to the true values for referring to the pulse length used. Even though these figures were given in specifications, all of the tests conducted on the QHD equipment where pulse lengths were involved were 33.3 milliseconds where 35 was specified, 11.1 milliseconds where 12 was specified, and 3.3 milliseconds where 3 was specified.

- r. The actual operating frequencies of the Wien bridge oscillator were 29.9 cps., 91.4 cps. and 291.3 cps.
- s. The frequency drift of the Wien bridge oscillator over a period of one hour from a cold start was less than 0.3 percent of any of the operating frequencies.

- t. When the 440-volt supply was varied \pm 20 percent, the Wien bridge oscillator frequency varied as shown:

<u>Line Voltage</u>	<u>Oscillator Frequency in cps</u>		
352	30.9	89.4	292
440	29.3	89.2	293
528	29.0	89.0	293

- u. All brightening amplifiers for the PPI and SSI scopes operating in connection with pulsing circuits and receivers were suitable for their purposes.
- v. The envelope filters were not incorporated in the receivers as stated in specifications but were located in the console assembly. They were designed to operate on pulse lengths of approximately 3, 12 and 35 milliseconds. When operating with a recorder there was a definite improvement in the signal to noise ratio. This feature may be disabled at the console by the Envelope Filter switch.
- w. Operation of Test Switches:
- 1) Stall Sweep. When the Stall Sweep switch was "ON", the spiral expand on the PPI and the vertical sweep on the SSI were prevented from expanding further. Thus the PPI spiral expand and the SSI vertical sweep could be stopped at any points of their travels.
 - 2) PPI Gated. When the PPI Gated switch was "ON", the PPI spiral expand was gated. The expand rate when the PPI was gated was the same as that for 600-yard range presentation. The time of the gating was determined by the range indicator setting.
 - 3) SSI Gated By. The position of the Gated By switch determined whether the SSI vertical sweep was gated by the range indicator or was controlled by the PPI sweep rate. When the switch was in the "Range Mark" position, the gating occurred according to the range indicator setting. When the switch was in the "OKA" position, the vertical sweep was not gated but had the normal PPI sweep rate. In order for the "SSI Gated By" switch to be operative the "SSI Gating" switch had to be turned on. The SSI vertical sweep rate when gated was the same as that for the 600-yard range presentation.

- 4) Sectioned Sweep. This switch made the sectioned sweep variable resistor operative, and caused the PPI spiral expand to enlarge at the 600-yard presentation rate at a time determined by the sectioned sweep resistor setting. Thus, with the range presentation switch set for any position, the gating would occur at any time between flybacks according to the sectioned sweep resistor setting. If the sectioned sweep resistor setting was higher than the setting of the range presentation switch there was no gating.
- 5) Listening Pattern. When this switch was "ON", the presentation on the PPI and SSI CRT was no longer under the control of the range selector switch but the diameter of the circle presented on the PPI and the amount of vertical travel of the presentation on the SSI CRT were determined by the amount of signal applied to the listening receiver. Ten microvolts of signal at the operating frequency applied to the listening receiver caused the presentations to expand fully on the PPI and SSI CRT.
- 6) Scanning Pattern. With this switch in its test position, the PPI presentation was a line from the bottom left of the tube face to the top right with a large amount of noise visible. This noise varied with the setting of the Pulse Length selector switch and the amount of bias on the grids of the scanning commutator tube. The presentation on the SSI CRT was not changed.
- 7) Envelope Filter. The envelope filter switch in the normal position would allow the enhancing output from the listening receiver to emphasize the target information on the recorder that could be connected in the QHD system, and to enhance the target information on the SSI CRT. However, as SSI gain was increased, the enhancing of the presentation on the SSI became less until at full gain there was no improvement.
- 8) Ping Length. When the ping length switch was in the "Test" position, the transmitted pulse length could be observed in the form of a spiral on the PPI CRT. When the pulse generator and scanning rates were operating properly, a single cycle spiral would appear at the center of the PPI CRT during transmission time.
- 9) Transmitted Ping Length Test. A second ping length test which included the operation of more of the equipment could be made by turning the Blanking switch off and placing the

Ping Length switch and Driver Input test switch, located in the Test Set, in the "Test" position. This test included the operation of the transmitting portion of the scanning receiver, part of the test set and signal brightening circuit of the console, as well as the pulse timing circuit. Again, when the sections were operating properly, a single cycle spiral would appear on the PPI CRT.

2. Receiver Assembly, Type R-354/SQS.

- a. The Scanning Receiver chassis contained the receiver amplifier, the first and second ultrasonic oscillators with their tuning reactance tubes, and a mixer circuit for the generation of the transmitted frequency followed by a suitable amplifier.
- b. The receiver amplifier section had two channels, one for broad band operation and the other for narrow band operation. When the QHD system was operating with a 35-millisecond transmitted pulse length, the narrow band channel was automatically switched on. When the system was operating with a 12 or 3-millisecond transmitted pulse length, the broad band channel was operative. The channel not in use was cut off by heavy biasing.
- c. The maximum voltage gain of the broad band channel was 112 db and the maximum voltage gain of the narrow band channel was 126 db. At full gain both channels were overdriven when 100 microvolts were applied to the receiver input. Overload characteristics for both channels are shown on Fig. 2.
- d. The pass band of the narrow band channel at the 6-db down points was 1.5 kc either side of the operating frequency. See Fig. 3.
- e. The pass band of the broad band channel at the 6-db down points was 4.5 kc either side of the operating frequency. See Fig. 4.
- f. The Scanning Receiver amplifier could be operated under three conditions of TVG (time variable gain) and RCG (reverberation controlled gain). First, it could be operated without TVG or RCG. Second, it could be operated with various amounts of TVG and no RCG. Third, it could be operated with RCG and various amounts of TVG.
- g. The time required for recovery of the receiver gain when various amounts of TVG alone were used is illustrated in Fig. 5.

- [REDACTED]
- h. Figure 6 illustrates the gain recovery time of the receiver with a fixed amount of TVG, with the RCG on and various amounts of signal applied to the listening and scanning receivers. Since the RCG circuit was operated from the signal received in the listening receiver, a signal had to be supplied to both the listening and scanning receivers in the proper ratio for an RCG test of the scanning receiver. Fig. 7 shows the scanning receiver recovery time with a constant signal applied to the receivers, RCG on, and different values of TVG.
- i. The first oscillator was a variable frequency type oscillator having a range from 79 kc to 87.5 kc. The main tuning dial, which controlled the first oscillator frequency, indicated this range as 19 kc to 27.5 kc as this was the operating frequency of the system when the first oscillator was beat with the 60-kc produced by the second oscillator. Since the first oscillator frequency was supplied to all receivers to produce the i-f frequency, and was beat with the second oscillator frequency to produce the transmitted frequency, the entire QHD system was under unicontrol. Thus, the main tuning controlled the operating frequency of the receivers and transmitter.
- j. The trimmer capacitor associated with the main tuning capacitor, when the latter was set for 19 kc, was capable of varying the system operating frequency \pm 5 percent. At 23 kc or 27.5 kc, the trimmer was capable of varying the oscillator \pm 7 percent.
- k. During a warm-up period of one hour and a half at room temperature and with the tuning reactance off, the oscillator frequency drift was 7 cycles. Under the same conditions but with the tuning reactance on the frequency drift was 140 cycles.
- l. Substituting different pre-heated tubes in the oscillator tube socket did not affect the frequency appreciably.
- m. With the tuning reactance on, the tuning reactance adjustment was capable of varying the operating frequency \pm 2.5 percent when tuned to 23 kc or 27 kc. When the operating frequency was 19 kc, the adjustment was \pm 3 percent.
- n. The frequency vernier, located on the console, adjusted the frequency of the first oscillator. However, the oscillator frequency correction was the opposite of that indicated on the dial. When adjusting for increased frequency, the oscillator frequency decreased and vice versa. Also, the decreased frequency range of the control was non-linear. Thus, at the minimum setting (-1.5 kc), the oscillator frequency changed 3 kc when the oscillator was tuned at 19 or 27 kc, and changed 2.6 kc when set at 23 kc.

- o. During transmission time, the frequency of the first oscillator changed according to the direction of the listening beam to correct for own ship's doppler. This change in frequency was correct for a ship speed of 17 knots. Fig. 8 shows the change in first oscillator frequency with respect to the direction of the listening beam. An ODN (own doppler nullification) disabling switch was incorporated.
- p. The frequency change of the oscillator when the line voltage was varied \pm 20 percent was five cycles when the tuning reactance was off. With the tuning reactance on and \pm 20 percent line voltage variation, the oscillator frequency change was 33 cycles.
- q. Specifications require the ultrasonic operating frequency to be constant within 0.2 percent of the frequency to which the equipment is tuned when the line voltage frequency is varied 5 percent. Facilities for this frequency variation were not available and the test was not made.
- r. The frequency change of the oscillator when the oscillator load was changed \pm 25 percent was 0.01 percent.
- s. The second oscillator was capable of operating at two frequencies. During transmission time the oscillator frequency was 60.0 kc, and during receiving time the oscillator frequency was 60.5 kc. The tuning reactance associated with this oscillator affected the oscillator frequency only during receiving time.
- t. The tuning capacitor was capable of adjusting the oscillator frequency 5 percent of the operating frequency.
- u. The "beat note adjustment", effective only during transmission time, was capable of adjusting the oscillator frequency 1.6 percent of the operating frequency.
- v. The ODN adjustment varied the oscillator frequency 4 percent of its operating frequency.
- w. The oscillator drift during a two-hour warm-up period, with the "sampling ODN" off, was 58 cycles. When the "sampling ODN" was on, but without any signal applied to the listening receiver and without the ODN relay operating, the frequency drift during a 1.5-hour warm-up period was 85 cycles. The large majority of this change occurred during the first minute of operation.

- x. Substituting different pre-heated tubes in the oscillator tube socket did not affect the frequency appreciably.
 - y. With the "Sampling ODN" off, a line voltage variation of \pm 20 percent produced no significant change in the oscillator frequency. The oscillator frequency change with \pm 20 percent line voltage variation but with the "Sampling ODN" on was nearly 700 cycles. This change in operating frequency was beyond the cut-off range of the filters used.
 - z. When the oscillator load impedance was changed \pm 25 percent, there was no significant change in the oscillator frequency.
-
- aa. The frequency of the second oscillator is controlled by the listening receiver output frequency by means of the discriminator rectifier and tuning reactance tube when the second oscillator ODN tuning reactance is on. This output frequency is in turn determined by the receiver input frequency, the first oscillator frequency, and the second oscillator frequency. However, when the QHD system was under operating conditions of normal echo ranging, it was found that the second oscillator frequency was not controlled by the receiver input frequency. The apparent reason for this is the transient noise produced in the listening receiver caused by the change from transmit time to receive time operation. Since the tuning reactance tube samples the output of the discriminator rectifier immediately after the transmitted pulse, the tuning reactance tube receives a voltage according to the frequency of the transient noise in the listening receiver and not the reverberation frequencies received. As a result, the second oscillator frequency was not determined by the frequency of the signal received but wandered over a range of three hundred cycles continuously. (See Fig. 9.) Occasionally, the drift was greater than four hundred cycles and oscillations stopped altogether. Without the second oscillator frequency, the listening receiver and the scanning receiver were inoperative.
 - bb. The signal generator amplifier mixes the first oscillator output with the transmit time second oscillator output and then amplifies this signal to a sufficient amplitude to drive the driver. This amplifier is normally cut off, but a pulse from the timer unit during transmission time removes the bias and allows the amplifier to operate. Filters are employed

[REDACTED]

in the amplifier in order that only frequencies between 19 kc and 27 kc, the operating frequency range of the equipment, may be amplified. The normal output of the amplifier is approximately 40 volts.

- cc. The Listening Receiver chassis contains the listening receiver amplifier, the discriminator rectifier, the enhancing circuit, and the RCG-TVG circuit.
- dd. The amplifier section has one channel which is used for all pulse lengths.
- ee. The maximum voltage gain of the amplifier was 134 db. At full gain, the amplifier overloaded when 40 microvolts were applied to the input. Overload characteristics are shown in Fig. 10. The pass band of the amplifier at the 6 db down points was 250 cycles either side of the operating frequency. For the entire frequency characteristic of the amplifier, see Fig. 11.
- ff. The amplifier operated under the same RCG-TVG conditions as the scanning receiver. The time required for the recovery of the receiver gain when various amounts of TVG alone are used is illustrated in Fig. 12. The gain recovery time of the amplifier with a fixed amount of TVG, with the RCG on and various amounts of signal applied to the receiver input is shown in Fig. 13. The effectiveness of the RCG is controlled by the amount of signal applied to the receiver. The gain recovery time of the receiver when operating with a fixed amount of input signal with the RCG on and various amounts of TVG is shown in Fig. 14.
- gg. The voltage out of the amplifier remained constant within $\pm .75$ db under combination of the following conditions: 1) any setting of the audio level control, 2) one, two, or three speakers connected to the receiver amplifier output, and 3) any setting of speaker attenuators or off-on switch.
- hh. The db meter on the audio output of the receiver indicated zero db with the following meter switch positions and applied signals to the receiver input:

<u>Meter Switch Position</u>	<u>Input Signal</u>
+ 7 db	0.5 microvolts
+17 db	1.6 "
+27 db	5.4 "
+37 db	30.0 "

ii. The discriminator rectifier had a normal operating range of 100 cycles below the zero voltage output frequency and 200 cycles above the zero voltage output frequency. The zero voltage output frequency was 590 cycles per second. If more than two volts were applied to the QDN relay tube, the circuit was overdriven and the discriminator rectifier no longer had the typical discriminator characteristics. See Figure 15.

jj. Under operating conditions the enhancing circuit supplied to the console a dc pulse whose length was determined by the length of the pulse received and with a maximum amplitude of two volts. Operation in connection with the envelope filters and SSI brightening was satisfactory.

kk. Bias supplied from TVG to the listening and scanning receivers could be varied from zero to 120 volts.

ll. RCG could be turned on or off by means of a suitable switch.

mm. The effects of various combinations of RCG and TVG on the receiver gains are shown in Figures 5, 6, 7, 12, 13 and 14.

nn. The SSI Receiver is a two-channel amplifier, the right channel being exactly the same as the left. The voltage gain of each channel was approximately 100 db at the lowest input voltage level that would cause the blocking oscillators in the output of the channels to operate. However, the voltage from the blocking oscillators remained constant as the input signal was increased. The maximum phase shift between the output voltages of the two channels when the input frequency was as much as \pm 200 cycles away from the correct operating frequency, and the input signal was varied from the threshold of operation to overload was \pm 1/2 degree as indicated by the raster of the SSI CRT. See Figure 16.

oo. When operating under normal input frequency and voltage conditions, but with the load on the output increased by 25 percent, the output voltage decreased 3 db. There was no voltage change when the load was decreased by 25 percent.

pp. Minimum input signal necessary to give an indication on the SSI CRT was 100 microvolts.

- qq. The test set is a vacuum tube voltmeter capable of measuring the pulse amplitude of pulses applied to it. When measuring pulse amplitude, several pulses must be applied, depending on the pulse length, in order for the meter integrating circuit to build up a voltage corresponding to the pulse amplitude. Normally, the test set monitors the signal transmitted by the standard section of the transducer by employing the MMC section for receiving purposes. When the system is operated under MCC conditions the monitoring cannot be accomplished as the MMC section is being used for transmission and is no longer connected to the test set.

Test switches are provided to allow the meter to also measure the pulse amplitude as applied to the driver. When this test is being made, the driver is no longer pulsed. The ratio of the voltage applied to the test set input to that indicated on the meter is approximately two to one. Thus, with a proper setting of the potentiometer at the test set input, a forty-volt signal will give a twenty-volt meter indication.

- rr. Switches are also provided in order that the pulse from the signal generator portion of the scanning receiver may be sent directly to the PPI CRT in the console. The transmitted pulse length may be measured by the PPI scanning rate.
- ss. Proper voltages required to operate the receivers are obtained from the receiver power supply. The test set has its separate power supply.

3. Amplifier-Commutator Assembly, Type AM-392/SQS.

- a. The frequency response of the forty-eight preamplifiers was flat within ± 0.5 db over the range of operation, 19 to 27 kc.
- b. Normally, the voltage gain of the preamplifiers is set for about 500 but can be varied over a large range. In the input circuit of each preamplifier there is a coupling transformer. The primaries of these transformers are connected through the transmit-receive transfer relay to the individual staves of the transducer. When the voltage applied to the primary reaches 1.2 volts, a neon bulb on the secondary of the transformer fires and reduces the voltage applied to the first amplifier tubes, protecting the grids. During transmission time the voltage leaking across the transmit-receive transfer relay occasionally reaches 1.2 volts, necessitating the protective device.
- c. A signal of one microvolt applied to the preamplifier input caused an indication on the PPI and SSI CRT's when the receivers were operated at maximum gain.

- d. The variable capacitors on the secondaries of the input transformers were capable of shifting the phase of the signal applied to the first tube \pm 16 degrees.
- e. The PPI scanning commutator beam rotated at approximately 30, 90 or 300 rps as selected by the operator.
- f. The SSI scanning commutators are trainable to any desired bearing, as selected by the operator. The training accuracy is determined by the dynamic and static accuracy of the training servo system. Since the servo system is capable of accepting single axis stabilization orders from the Mk 23 Computer, the changes will be reflected in the commutator beam bearings.
- g. The frequency response of the commutator tubes and their coupling amplifiers was flat within \pm 0.5 db over the operating range of the equipment.
- h. When a signal is applied to any one grid of the listening commutator tubes and the electron beam directed in the vicinity of the grid, a fairly constant signal out of the coupling amplifier results when the beam is displaced by \pm 2 or 3 degrees from the grid bearing. Further displacement produces a rapid decrease in output voltage. The physical bearing difference between each grid is 7.5 degrees and the apparent center of each voltage plateau varies from this value by plus or minus one degree. Each grid has a different output characteristic as the beam bearing is changed. A comparison of the voltage gains of all the grids showed a variation of \pm 1.5 db.
- i. When signals of equal phase and amplitude were applied to corresponding grids of the right and left commutator tubes and the electron beam trained in the vicinity of the grids, the phase between the voltages at the output varied as much as \pm 8 degrees over the effective bearing range of the grids. This did not result in a 16-degree change in target bearing as indicated on the SSI CRT, as the ratio of actual signal phase shift applied to the SSI receiver to that indicated on the SSI CRT was about 8 to 1. Thus, over the effective bearing range of each pair of the listening commutator grids, the error appeared on the SSI CRT as plus or minus one degree or less. Of course, if the electron beams can be aimed at the effective centers of each pair of grids, the apparent error approaches zero.
- j. Typical overload characteristics of the commutator tubes is shown in Figure 18.

CONFIDENTIAL

UNCLASSIFIED

- k. Even though the noise level (10 millivolts) applied to the input of these tubes was high compared to the signal amplitude necessary (10 microvolts) to cause an indication on the PPI CRT, the noise did not appear to affect the operation of the equipment. This noise had several components, including 60 cycles, the scanning rate of the tube, and some small amplitude frequencies of 3,000 cycles or more. Most of the noise was 60-cycle. The various scanning rates had no effect on the gain of the tubes.
 - l. The permanent magnet tilt adjustment on the listening commutator tubes appeared to have ample range. Also, the voltage applied to the tilt coil of the scanning commutator tube appeared to have the correct amplitude.
 - m. The bias controls for the commutator tubes had proper ranges of adjustment.
 - n. The scanning field amplifier had sufficient output and proper wave shape at all scanning rates to properly rotate the electron beam in both the scanning commutator tube and the storage scanning tube.
 - o. The scanning commutator selector switch assembly is located on the back of the commutator assembly and contains manually operated switches for switching the equipment to either "normal" or "storage operation". The system operated properly in either switch position.
 - p. The power supply unit, with one exception, provided the correct voltages for all units of the assembly. The exception was that the plate supply for the scanning field amplifier was 400 volts instead of 360 volts.
 - q. Pulse delay network units, Z-1112, Z-1114 and Z-1129 were found to be defective (internal shorts). They were replaced with spare units. The defective units were returned to the contractor for repair.
4. Servo Amplifier Assembly, Type AM-393/SQS.
- a. The Deflection Amplifier provided the necessary voltages to the deflection coils on the Console and remote PPI's with a minimum amount of distortion at all scanning rates. Power was derived from a suitable self-contained power supply.
 - b. The Servo Amplifier chassis contains the necessary four separate servo amplifiers, training servo, listening commutator servo, PPI stabilization servo, and the PPI true-relative servo amplifier. The chassis also contains the slewing switch relays, and a power supply for the amplifiers.

- c. Meters are provided to show the electrical error in degrees of the Brq servo amplifier, and the listening commutator servo amplifier.
- d. Operation of all sections was satisfactory.
- e. Most of the synchro control system is located in the servo unit. The control system is capable of accepting the following synchro inputs:

Synchro Order	Speeds	From	Into
cBrq	36X	Attack Director	Azimuth Train
B'r'q	1X & 36X	Mk 23 Computer	Listening Channel Switch
Co	1X	Gyro Compas	Azimuth Train
Co	36X	Gyro Compass	Azimuth Train
Zero Order	-	Transformer	Azimuth Train
Brq	1X	Attack Sonar	Cursor on PPI and remote PPI's

- f. The equipment is capable of providing the following synchro outputs:

Synchro Order	Speeds	From	Into
Brq	1X & 36X	Azimuth Train	Attack Director, Mk 23 and Attack Sonar
Brq	1X	Azimuth Train	Cursors on remote repeaters and Attack Sonar
Bq	1X	Azimuth Train	Attack Plotter

- g. The training wheel, located on the Console, is so geared that each revolution of the handwheel in either direction results, correspondingly, in fifteen degrees of azimuth train of the listening channel beam.
- h. Right or left slewing of the directed listening channel is provided at a speed of 8 rpm. The slewing switch is located on the Console.
- i. The dynamic accuracy of the listening channel training system was tested by feeding an electrical signal into the one speed system represented by the formula $30\sin 5\pi t/11$. This formula is interpreted to mean a signal that will cause the listening channel training system to reverse its direction of rotation periodically as a sine function. The time required for one

[REDACTED]

complete cycle is 4.4 seconds and the amplitude of the excursion is 30 degrees, total travel being 60 degrees.

Under these conditions the training servo amplifier error meter indicated a maximum lag error of 7.7 minutes in the clockwise direction and 6.4 minutes in the counterclockwise direction.

The listening commutator servo amplifier error meter indicated a maximum lag error of 8.9 minutes in the clockwise direction and 6.8 minutes in the counterclockwise direction.

All of the errors are within the specification limit of 10 minutes.

- j. The static error at all bearings was three minutes or less, which is within specification limits of five minutes.
- k. Relay K-4303 a 1X and 36X changeover relay in the servo amplifier was replaced with one from spares. The original had sluggish armature action.

5. Sonar Driver-Amplifier, Type AM-394/SQS.

- a. The driver was capable of supplying at least 40 kilowatts over the operating frequency range of the equipment, 19 to 27 kc. Means are provided to reduce the driver power output in two steps of 10 db each.
- b. Figure 17 shows the frequency characteristics of the driver with various tuning capacitors used.
- c. The power output of the driver at the end of a 35-millisecond pulse did not decrease by more than 10 percent of the maximum value.
- d. The driver power output is automatically reduced 3 db from full power when operated under MCC conditions.
- e. The driver can be keyed automatically from the Console. It can also be keyed from the Console by a hand telegraph key, or by a test key button on the driver. Normal driver power output under hand-keyed conditions is 400 watts.
- f. The driver is capable of being keyed to supply 35, 12 and 3-millisecond pulses with scanning rates of 30, 90 and 300 cycles per second respectively.

- g. With a ± 10 percent change in the 440-volt supply, the driver power output varied as shown in the table below:

<u>Line Voltage</u>	Driver power output in kilowatts			
	Full Power	MCC Operation	-10 db Position	-20 db Position
484	50	22.5	4.4	1.0
440	40	20	4.0	0.4
396	27.5	12.5	3.5	0.05

- h. Except for the driver, the equipment was operable within a few seconds after power was applied. The warm-up time for the driver was two minutes and twelve seconds.
- i. When the driver is turned on its blower motor starts immediately and continues to run for four and one-half minutes after the driver is turned off.
- j. The driver disabling switch disables the driver without affecting the rest of the equipment.

6. Transducer, Type CRP-51117-A.

- a. Preliminary tests on the transducer showed that the transmitting response of the MCC section was extremely poor. The transducer was returned to the contractor on 8 May 1952 for correction. On 3 September 1953 the transducer was delivered to the Laboratory and tests were continued.
- b. The individual elements appeared to make uniform acoustic contact with the water, although the sensitivity of several of the individual staves were not within ± 2 db of the mean. See Figure 19.
- c. Impedances of two of the individual staves were not within ± 10 percent of the mean as required by specification. See Figure 20.
- d. The phase angles of several of the individual staves were not within ± 3 degrees of the mean. See Figure 20.
- e. When the transducer was operated under MCC conditions (with connections as shown in wiring diagram), the transmitted beam was deflected upward instead of downward. See Figure 21. The MCC transmitted beam was deflected downward when these leads were reversed. See Figure 22.
- f. With MCC operation there was practically no nullification of the beam in the horizontal plane, and the transmitted signal amplitude at the required angle (60 degrees) was so

[REDACTED]

low (-17db) compared to the maximum that detection of under-water targets would be doubtful. See Figure 22.

- g. The average transmitting response for the MCC section of the transducer was 63.4 db above one dyne per square centimeter at a distance of one meter with one watt in the MCC section. This was 9.6 db below specification limits. See Figure 23.
- h. The resonant frequency of the transducer was 26 kc \pm 5 percent. See Figure 24.
- i. The Q of the transducer was calculated to be 7.5, well within specification limits. See Figure 24.
- j. The efficiency of the transducer standard section computed from the sound output divided by the electrical input was 14 percent. This efficiency was based on a transmitting directivity index of 8.7 db.
- k. As previously stated, the transmitting directivity index of the standard section was 8.7 db, or 2.8 db below specification requirements.
- l. The directivity index of the receiving beam patterns before commutation was not 28 db as required by specifications. Figures 36 through 43 present the receiving beam patterns every 45 degrees before commutation.
- m. The sound radiation pattern (main lobe) in the horizontal plane of the standard section of the transducer was not within \pm 2 db of the mean. See Figure 25. The angular beam width of the main transmitted beam at points 10 db down was within the specification requirements of 16 degrees, although three of the side lobes were slightly higher than the allowed -10 db. See Figure 26.
- n. The average transmitting response for the standard section of the transducer was 70.2 db above one microbar at a distance of one meter with one watt in the transducer. This value is 6.8 db below specification requirements. See Figure 25.
- o. The open circuit receiving response of the transducer (all staves connected parallel aiding) was not within \pm 2 db of the mean as required by specifications. See Figure 27.
- p. The angular horizontal receiving beam width of the transducer when associated with the commutator tubes and the lag lines was not 17 degrees as required by specifications nor were the side lobes down 18 db from the main lobe. Figures 28 through 35 present the receiving beam patterns every 45 degrees

[REDACTED] after commutation.

- q. The transducer operated satisfactorily during the "locked key" operation test. The average power supplied to the transducer during the 24-hour period was 400 watts. No deleterious effects were noted on the transducer under these power conditions and with the water temperature varied between 39 degrees and 90 degrees Fahrenheit.
- r. The transmitting response of the MCC section in the vertical plane is shown in Figure 44.
- s. During the "keyed operation" test the water temperature was varied between 32 degrees and 88 degrees Fahrenheit and the average power supplied to the transducer was 40 kilowatts during the 35-millisecond pulse. The pulse repetition rate was the most rapid possible, that for the 2000-yard range presentation. No pernicious effects were observed on the transducer during or after the 48-hour test.

7. Power Transformer, Type CRP-301223.

These units were satisfactory under normal operation and with ± 20 percent line voltage variations.

8. Motor-Generator Assembly, Type PU-200/U.

- a. The 3-phase 440-volt ac motor, rated at 10 horsepower, drives two dc generators. The dc generators are each rated at 2800 volts dc at 0.6 ampere rating when driven at a speed of 3600 rpm. Maximum power rating of each generator is 5.25 kw. The 2800-volt generators are separately excited by a 440-volt dc generator with a current capacity of 1.8 amperes. The high voltage generators supply the necessary voltage and power required by the driver.
- b. Prior to the beginning of electrical tests, the high voltage generator unit G-33/U, serial 3, was found to have a defective armature (open coils). A new armature was installed and the defective armature returned to the contractor. Cause of failure is unknown.
- c. The second generator armature failure occurred after the completion of the shock and vibration tests. During these tests there was no hint of generator malfunction. However, during the driver vibration test the driver power output was lower than experienced previously even though 40 kw could still be obtained. During the driver shock test the motor generator would not provide the required voltage during

transmission time and investigation revealed open armature coils in this case also. Although the failure occurred after the shock and vibration tests of the motor generator, it is not certain that the failure was the result of these tests.

9. Motor Starter, Type CAE-211981

A suitable motor starter with an overload relay and overload reset was provided. The operation of this unit was satisfactory under normal conditions and with ± 20 percent line voltage variations.

10. Relay Assembly, Type RE-84/SQS.

All of the relays and other components in this assembly functioned properly for the normal operation of the system.

11. Receiver-Storage Scanner Assembly, Type R-522/SQS.

- a. The power consumed by the storage amplifier unit from the 110-volt single-phase supply when operating at full gain was 1200 watts at 0.98 power factor.
- b. The 300-volt regulated power supply regulated within ± 0.3 percent under conditions of ± 10 percent line voltage variations and maximum or minimum settings of the master gain control.
- c. The regulation of the 100-volt regulated power supply under conditions of ± 10 percent line voltage variation and maximum or minimum settings of the master gain control was as follows:

Master Gain Setting	Line Voltage	100-Volt Supply	Percent Change
Maximum	117	100	0
Minimum	117	107	7
Maximum	129	100	0
Minimum	129	120	20
Maximum	105	96	4
Minimum	105	100	0

Specifications require that there be no more than one percent change in output voltages.

- d. A scanning commutator tube, type QK-255, capable of commutating dc signals at a rate of 300 rps is provided.

- e. A scanning commutator brightening amplifier capable of supplying sufficient signal to the console PPI is supplied.
- f. Test points are provided on each storage amplifier unit for measurement of the ac voltage supplied to the rectifier and storage section, and are also provided to measure the dc output. In addition, test points are provided in the brightening amplifier.
- g. Five of the individual storage amplifiers were selected at random for frequency response tests. All five were found to have their pass bands centered on a frequency of 25.5 kc. The frequency response of amplifier number 41 was selected as typical and is presented in Fig. 45.
- h. At frequencies of 24.5 and 26.5 kc, the amplifier response was down 0.3 db and 3.8 db respectively. Specifications state that it shall be down 6 db. See Fig. 45.
- i. The output voltage over the range of the pass band did not vary by more than ± 1 db from the mean; this variation is within specification limits. See Fig. 45.
- j. Under conditions of full gain and a source impedance of 500 ohms, the noise level of the majority of the amplifiers tested was within the specification limit of 0.5 volts or less. However, amplifiers numbers 21 and 31 were found to have noise levels of 0.65 and 0.55 volts respectively.

During these tests it was found that the shielded cable capacitance and the test meter input capacitance used to measure the output voltages produced a loading effect on the output circuit. All voltage measurements made were taken with as short a cable as possible but probably if the load on the circuit could have been reduced to zero, higher readings would have been obtained. This, of course, would result in more of the units failing to meet specifications due to an excessive output noise level.

- k. At the center of the pass band, with an input load impedance of 500 ohms the input signal required to produce an output of 20 db above the noise level was four microvolts or less for all of the units tested.
- l. For the AVC regulation test, 20 percent of the amplifiers were checked. Except for amplifiers number 11 and number 16, the AVC regulated the output of each unit within the limits of ± 0.5 db from the mean over the range of 100 microvolts to one volt. See Fig. 46.

- m. Except for amplifier number 11, the AVC regulated the output of each amplifier tested within the limits of ± 1 db from the mean with an input of 40 microvolts. See Fig. 46.
- n. Specifications require the AW to be delayed sufficiently so that a 35-millisecond pulse is not decreased by more than 10 percent in amplitude during the period of its reception.

When the equipment was operating under "storage" conditions and a 35-millisecond pulse was applied to the preamplifier inputs in the scanning commutator unit, the pulse amplitudes from the storage scanner did not decrease by more than 10 percent except when the applied signal was less than two microvolts. (See Fig. 47.) However, under these input conditions the AVC decreased the ac signal at the output of the individual storage amplifiers by almost 100 percent when a 35-millisecond pulse was used. (See Fig. 48).

As seen on Fig. 47, the signal output from the storage scanner under normal operating conditions was forty times greater than required to produce a recognizable display on the PPI CRT. This characteristic produced a very definite target display on the PPI tube.

- o. Specifications require the rectifier and storage networks to discriminate against signals of longer and shorter duration than 35 milliseconds. When the signal was longer than 35 milliseconds, there was partial discrimination as seen on Fig. 49. If the signal amplitude was at least two microvolts and the duration was of the order of twice the normal pulse length, the discrimination did not become effective until 40 milliseconds after the signal was initiated.
- p. The storage network and AVC in each storage amplifier did not operate so as to discriminate against pulses of shorter duration than 35 milliseconds. See Fig. 50.

12. Loudspeaker, Type LS-168/U.

When connected in parallel to the audio output, the power supplied to the four speakers was sufficient for good aural response. The loudspeakers were inoperative when the headphones were used.

13. Azimuth Range Indicator (PPI), Type IP-95/SQS.

- a. The remote PPI units satisfactorily repeated all sonar information presented on the PPI scope in the Console assembly, as well as cursor information from the attack sonar equipment.

- b. Switching means were provided on the units for turning them on and off.
- c. Lighted indicators were provided on the units to show the range scale presented on the scope.
- d. All necessary scope adjustment controls were provided.
- e. The QHD system was designed to accommodate from one to five remote PPI units. Three were supplied for this test.

14. Azimuth Range Indicator (SSI), Type IP-96/SQS.

- a. The remote SSI units satisfactorily repeated all sonar information presented on the SSI scope in the Console assembly.
- b. Switching means were provided on the unit for turning it on and off.
- c. Lighted indicators were provided to show the range scale presented on the scope.
- d. All necessary scope adjustment controls were provided.
- e. The QHD system was designed to accommodate from one to three remote SSI units. One unit was supplied for this test.

15. Headphones, Type CRP-49621

The headphones (two pair) operated properly when either one was plugged into a phone jack.

D. Temperature and Humidity

1. Mechanical

a. Console Assembly C-706/SQS

(1) Temperature: No failures.

(2) Humidity:

Rust on main framing mainly along edges, at welded joints, in and around screw and bolt holes, on cut-out for blower motor exhaust port.

Rust on top covers of transformers T-2301, T-2302, T-2303, and T-2304, on heater element assembly R-2101, on cover cap of P-2303, and on retainer ring of indicator lamp housings I-2108 and I-2109, on Allen wrenches,

[REDACTED]

on two Allen head screws of training handwheel assembly, on shaft bushing of training handwheel, on springs of SSI and PPI control panel cover plate, on spring of SSI cursor adjustment assembly, on the bottom right side of the switching panel in the Sweep Generator unit, on the front cross brace bar of the chassis slide frame, and in the Timing Unit on the inserts for the holding screws of the back cover plate.

Corrosion on the cover plate of the 110-volt service outlet.

b. Receiver Assembly R-354/SQS

(1) Temperature: No failures.

(2) Humidity:

Rust on main framing mainly along edges, at welded joints, in and around screw and bolt holes, and at cut-outs.

Rust on the chassis slide bars of the Power Supply, SSI, Scanning and Listening units, on the mounting plate for the 110-volt service receptacle, on metal containers of C-3333, C-3340, C-3346, C-3706, L-3701, L-3702, L-3801, L-3802, T-3304, T-3305, T-3306, T-3701, T-3801, Z-3303, and Z-3304.

Corrosion on the angle braces for the front cover of the Test Unit, on lock nuts for the Fusetron holder, on the mountings of F-3701, F-3702, R-3705, R-3706, and T-3802, and on all the hardware of the SSI receiver chassis.

c. Amplifier Commutator Assembly AM-392/SQS

(1) Temperature: No failures.

(2) Humidity:

Rust on main framing along edges, in and around screw and bolt holes, and on some of the welded joints.

Rust on base plate of tube socket XV-1804, on the knurled holding bolt for the relative bearing unit, on several of the metal containers for the pulse delay network filters.

Corrosion on the removable cover plugs for the lifting eye-bolt holes.

[REDACTED]

d. Servo Amplifier Assembly AM-393/SQS

(1) Temperature: No failures.

(2) Humidity:

Rust on main framing in and around screw and bolt holes, and on the majority of the welded joints.

Rust on the back plate of the chassis release lever cover blocks, on the retainer piece of the chassis maintenance lock, on the housings of G-4202, G-4204, and G-4207, on mounting rings of V-4101, V-4102, and V-4103, on holding clamps of C-4101 and C-4102, and on the metal cases of T-4301 and T-4305.

Corrosion on the removable cover plugs for the lifting eye-bolt holes.

e. Driver-Amplifier AM-394/SQS

(1) Temperature: No failures.

(2) Humidity:

Rust on main framing mainly along edges, at welded joints and in and around screw and bolt holes.

Rust on transformer cases (mainly on top covers) of T-802, T-803, T-804, T-805 and T-807, on supports for E-806, and on the laminations of the time meter relay K-804.

Corrosion on some of the hardware, on the air stream guides, on guide pins of the tube shield assemblies of V-803 and V-804, and on the hanger assembly of the blower motor B-801.

f. Transducer CRP-51117-A

(1) Temperature: Not tested.

(2) Humidity: Not tested

g. Power Transformers CRP-301223

(1) Temperature: Not tested.

(2) Humidity: Not tested.

[REDACTED]
h. Motor-Generator Assembly PU-200/U

Temperature and Humidity: No tests were made as the unit was too long to be accommodated in the test chamber.

i. Motor Starter Type CAE-211981

(1) Temperature: Not tested.

(2) Humidity: Not tested.

j. Relay Assembly RE-84/SQS

(1) Temperature: No failures.

(2) Humidity:

Rust on back mounting strip bolt holes, a few rust spots on top edge of C-509, C-510, C-511 and C-512.

Corrosion on holding brackets of C-501, C-502, C-503 and C-504.

k. Receiver—Storage Scanner R-522/SQS

(1) Temperature: No failures.

(2) Humidity:

Rust on Main framing mainly at welded joints and in and around screw and bolt holes.

Rust on practically all of the transformer and filter containers in each amplifier unit.

l. Loudspeaker LS-168/U

(1) Temperature: No failures.

(2) Humidity: No failures.

m. Azimuth Range Indicator (PPI) IP-95/SQS

(1) Temperature: No failures.

(2) Humidity: No failures.

n. Azimuth Range Indicator (SSI) IP-96/SQS Serial No. 1

(1) Temperature: No failures

(2) Humidity:

Rust on chassis slide bar, on C-102 and C-117, and Allen wrench was completely rusted.

2. Electrical

a. Console Assembly C-706/SQS

(1) Temperature:

During the temperature test, the 30-cycle and 300-cycle oscillators performed normally, but at a temperature of -20 degrees C. the 90-cycle oscillator operated at a frequency of 63 cycles for a short time. Also, after the temperature had been stabilized at 50 degrees C. for two hours, the 90-cycle oscillator frequency was 63 cycles, and did not recover when the temperature was reduced to 30 degrees C. During the time that the 90-cycle oscillator was operating at 63 cycles, the oscillator output voltage decreased to about half the normal value.

During the temperature decrease from ambient room temperature (approximately 24 degrees C.) to -20 degrees C., the spiral expand did not expand to the end of the raster when the temperature reached 0 degrees C. The expand lacked about half an inch when the 6000-yard range presentation was used. Proportionally smaller amounts of spiral decrease were observed on the lower range presentations. Although the spiral expand recovered occasionally at moderate temperatures (20 to 30 degrees C.), the reduction prevailed throughout the test. Due to the lack of normal spiral expand the SQS and QHD bearing markers were short and sometimes disappeared altogether on the 6000-yard range presentation.

During the time the temperature was increased from -20 degrees C. to plus 10 degrees C., the stern mark cursor increased in bearing by about 15 degrees.

(2) Humidity:

When the equipment was energized after raising the temperature from 10 degrees C. to 30 degrees C. and with the humidity at 65 percent, the following failures occurred:

There was no keying.

- There was no spiral expand on the PPI.
- The regulated 225-volt supply was 275 volts.

After ten minutes of operation the spiral expand recovered, but the expand was short on the 6000-yard range presentation.

After fifteen minutes of operation, the 225-volt supply recovered along with the keying, but the spiral expand on the 6000-yard range presentation was still short.

After a 96-hour period of 40 degrees C. and 95 percent humidity, the equipment was energized and the following failures occurred:

- There was improper keying on all pulse lengths
- No spiral expand or SSI expand.
- The 225 volt regulated supply was 280 volts.
- There was no brightening on the PPI CRT even with maximum threshold.
- The 310-volt regulated supply was 330 volts.

After five minutes of operation, the 225-volt supply had nearly recovered.

After ten minutes of operation and with the humidity decreased to 75 percent, the keying operated normally. Also, the SSI expand recovered, but there was no PPI expand.

Finally, at a temperature of 25 degrees C. and 69 percent humidity, all sections recovered except for the SQG bearing mark on the 6000-yard range presentation. Also, the spiral expand had become too large and had to be readjusted.

b. Receiver Assembly R-354/SQS

- (1) Scanning Receiver Temperature Test: Both the broad band and narrow band amplifiers operated normally throughout the test.

The amplifier section of the signal generator functioned properly.

[REDACTED]

Specifications require that the ultrasonic operating frequency of the equipment shall remain constant within 0.2 percent of the operating frequency under any 10-degree C. variation in ambient temperature between the limits of 10 degrees C. and 55 degrees C. This is interpreted to mean that when the operating frequency is set at any one temperature within this range, and the temperature is then changed 10 degrees C., that the frequency to which the system has drifted is considered the operating frequency for any further 10-degree C. temperature change, even though the initial temperature change may cause the system frequency to drift beyond specification limits based on the original frequency. Under these conditions, the system frequency may drift a total of 156 cycles in one direction when the temperature is increased from 20 degrees C. to 50 degrees C., and still be within specification limits, the limit for a 10-degree C. temperature variation being 52 cycles.

As seen in Fig. 51, the system frequency drift was nearly within specification limits as long as the temperature change was held for less than one-half hour. If the increased temperature was held for more than one-half hour, the frequency drifted well beyond specification limits. (See frequency change between 40 degrees C. and 50 degrees C. on Fig. 51) This was for operation with the first oscillator tuning reactance "off". Fig. 52 shows the equipment operating frequency drift under the same temperature variation conditions but with the first oscillator tuning reactance "On". As may be seen from the graph (Fig. 52), the frequency drift is less than with the tuning reactance off, but is still beyond specification limits when the increased temperature is held for more than one-half hour.

There are no specifications for the individual oscillator drifts, but Fig. 53 through 57 show the individual oscillator drifts under all conditions of tuning reactance, and receiving and transmission time.

Fig. 57 shows the second oscillator frequency variation as the temperature was changed, with the tuning reactance "on". The values shown are not a true indication of the oscillator frequency as its frequency varied continuously in a manner as shown in Figure 9. Also, notice that the operating frequency was approximately 1000 cycles below the correct second oscillator frequency. This erratic operation was not an effect of the temperature test but was due to noise in the listening receiver during the change from transmit time operation to receive time operation. For further explanation of the incorrect second oscillator tuning reactance operation,

[REDACTED]
[REDACTED]
see section IV., C., 2., aa.

- (2) Scanning Receiver Humidity Test: When the equipment was energized after the temperature increase from 10 degrees C. to 30 degrees C. and with 90 percent relative humidity the following failures occurred:

With the first oscillator tuning reactance "off", the first oscillator frequency increased 800 cycles. This was far beyond the equipment operating frequency specification limits of 52 cycles assuming no second oscillator frequency change.

The transmit time second oscillator frequency change amounted to 77 cycles. Assuming no first oscillator frequency drift, the 77-cycle change would produce an equipment operating frequency change of more than the allowed 52 cycles.

With the first oscillator tuning reactance "on", the first oscillator frequency increased almost 3000 cycles, well outside the proper operating region of the oscillator.

With the second oscillator tuning reactance "on", the second oscillator did not operate at all. Even though the second oscillator tuning reactance should have had no effect on the transmit time second oscillator frequency, this frequency changed more than a thousand cycles with the tuning reactance on. With the tuning reactance "off", the frequency change was only 77 cycles as stated above.

The scanning receiver receiving channels, broad and narrow, operated satisfactorily even though the voltage output decreased about two-thirds. This was probably the result of the large first oscillator frequency change causing the IF channels of the receiver section to operate at an incorrect frequency.

The equipment was energized after the 96-hour period of 40-degree C. temperature and 95 percent relative humidity, and the following failures occurred in the Scanning Receiver:

With the tuning reactance "off", the first oscillator frequency was 350 cycles below the correct operating frequency. Assuming no second oscillator frequency drift this change would result in a

[REDACTED]

350-cycle equipment operating frequency change, well beyond the allowed 52 cycles.

The second oscillator transmit time frequency decreased 200 cycles. Assuming no first oscillator frequency drift, the 200-cycle change would produce a 200-cycle equipment operating frequency change, which would not meet specification limits of 52 cycles.

With the first oscillator tuning reactance "on", the first oscillator frequency was 550 cycles below the correct frequency. Assuming no second oscillator frequency drift, the 550-cycle change would result in a 550-cycle equipment operating frequency change, which would not meet specification limits of 52 cycles.

With the second oscillator tuning reactance "on", the receive time oscillator did not operate.

Even though the transmit time oscillations of the second oscillator are supposedly not controlled by the tuning reactance, the second oscillator during transmitting time did not oscillate at all. In the previous test, but with the tuning reactance "off", there were oscillations but of the wrong frequency.

After three hours at a temperature of 16 degrees C. and a relative humidity of 60 percent, the second oscillator recovered and operated at nearly the correct frequency.

- (3) Listening Receiver Temperature Test: Considering the first and second oscillator frequency changes, the Listening Receiver operated normally throughout the temperature test.
- (4) Listening Receiver Humidity Test: No failures.
- (5) SSI Receiver Temperature Test: No failures.
- (6) SSI Receiver Humidity Test: No failures.
- (7) Test Set Temperature Test: No failures.
- (8) Test Set Humidity Test: When the equipment was energized after the temperature increase from 10 degrees C. to 30 degrees C. and with 90 percent relative humidity, the Test Set indicating meter reading was approximately

[REDACTED] one-tenth of the correct value.

After the 96-hour period of 40 degree C. temperature and 95 percent relative humidity, the equipment was energized and the Test Set meter failed to give a correct reading. Only after three hours at a temperature of 16 degrees C. and a relative humidity of 60 percent did the Test Set recover completely, although a partial recovery was experienced as soon as the temperature was lowered.

c. Amplifier Commutator Assembly AM-392/SQS

There were no failures in this assembly during the temperature and humidity tests.

d. Servo Amplifier Assembly AM-393/SQS

(1) Temperature test: No failures.

(2) Humidity Test: Except for a distorted and noisy output from the deflection amplifier when the equipment was energized after the 96-hour period of 40 degrees C. and 95 percent relative humidity, there were no failures during the humidity tests. The distortion and noise from the deflection amplifier disappeared after a few minutes of operation.

e. Driver-Amplifier AM-394/SQS

(1) Temperature test: Except for two blown fuses, there were no driver failures during the temperature test. The fuse failures occurred at a temperature of -20 degrees C. and at -10 degrees C., when the driver was being switched from low to high power. F-803 failed on both occasions.

(2) Humidity test: Since the driver and console units were tested in the chamber at the same time, the driver was not energized at the same time as the console because if the keying, which originates in the console, was not correct, injury to the driver might result. When the keying had recovered, fifteen minutes after the console was energized, the driver was energized and fuse F-801 failed. A new fuse was installed and operation was normal.

After the 96-hour test at 40 degrees C. and 95 percent relative humidity, the driver could not be energized immediately due to improper keying in the console unit. Thirty minutes after the console was energized the driver was turned on. When pulsed both high voltage

[REDACTED]
[REDACTED]
fuses failed, F-801 and F-802. New fuses were installed and operation was normal.

f. Transducer CRP-51117-A

- (1) Temperature -- not tested.
- (2) Humidity -- not tested.

g. Power Transformers CRP-301223

- (1) Temperature -- not tested.
- (2) Humidity -- not tested.

h. Motor-Generator Assembly PU-200/U

- (1) Temperature -- not tested.
- (2) Humidity -- not tested.

i. Motor Starter Type CAE-211981

- (1) Temperature -- not tested.
- (2) Humidity -- not tested.

j. Relay Assembly RE-84/SQS

- (1) Temperature test: No failures
- (2) Humidity test: No failures

k. Receiver Storage Scanner R-522/SQS

(1) Temperature test:

Except for an occasional five-volt variation in the regulated 100-volt supply when the temperature was less than zero degrees C., there were no failures in the Storage Unit during the temperature test.

(2) Humidity test: When the equipment was energized after the temperature increase from 10 degree C. to 30 degrees C. with 90 percent relative humidity, the following failures occurred:

The regulated 100-volt supply was 84 volts.

The storage amplifiers would not function.

[REDACTED]

There was a large constant signal from the Storage Unit causing an uncontrollable brightening on the console PPI CRT.

After fifteen minutes of operation with 85 percent relative humidity, the regulated 100-volt supply recovered to 95 volts. Operation as seen by the PPI presentation was near normal, but the brightening was still too high.

After twenty-two minutes of operation, the unit functioned normally.

After the 96-hour period of 40 degrees C. and 95 percent relative humidity the equipment was energized, and except for the regulated 100-volt supply being 95 volts and the regulated 300-volt supply being 295 volts, there were no failures. PPI presentation on the Console was normal.

l. Loudspeaker LS-168/U

- (1) Temperature test: No failures.
- (2) Humidity test: No failures.

m. Azimuth Range Indicator (PPI) IP-95/SQS

- (1) Temperature test: No failures
- (2) Humidity test: No failures.

n. Azimuth Range Indicator (SSI) IP-96/SQS

- (1) Temperature test: No failures.
- (2) Humidity test: No failures.

V. SHOCK AND VIBRATION

See NRL Memorandum Report No. 3853-354A/53.

UNCLASSIFIED

ILLUSTRATIONS

FOR

NRL MEMORANDUM REPORT NO. 192

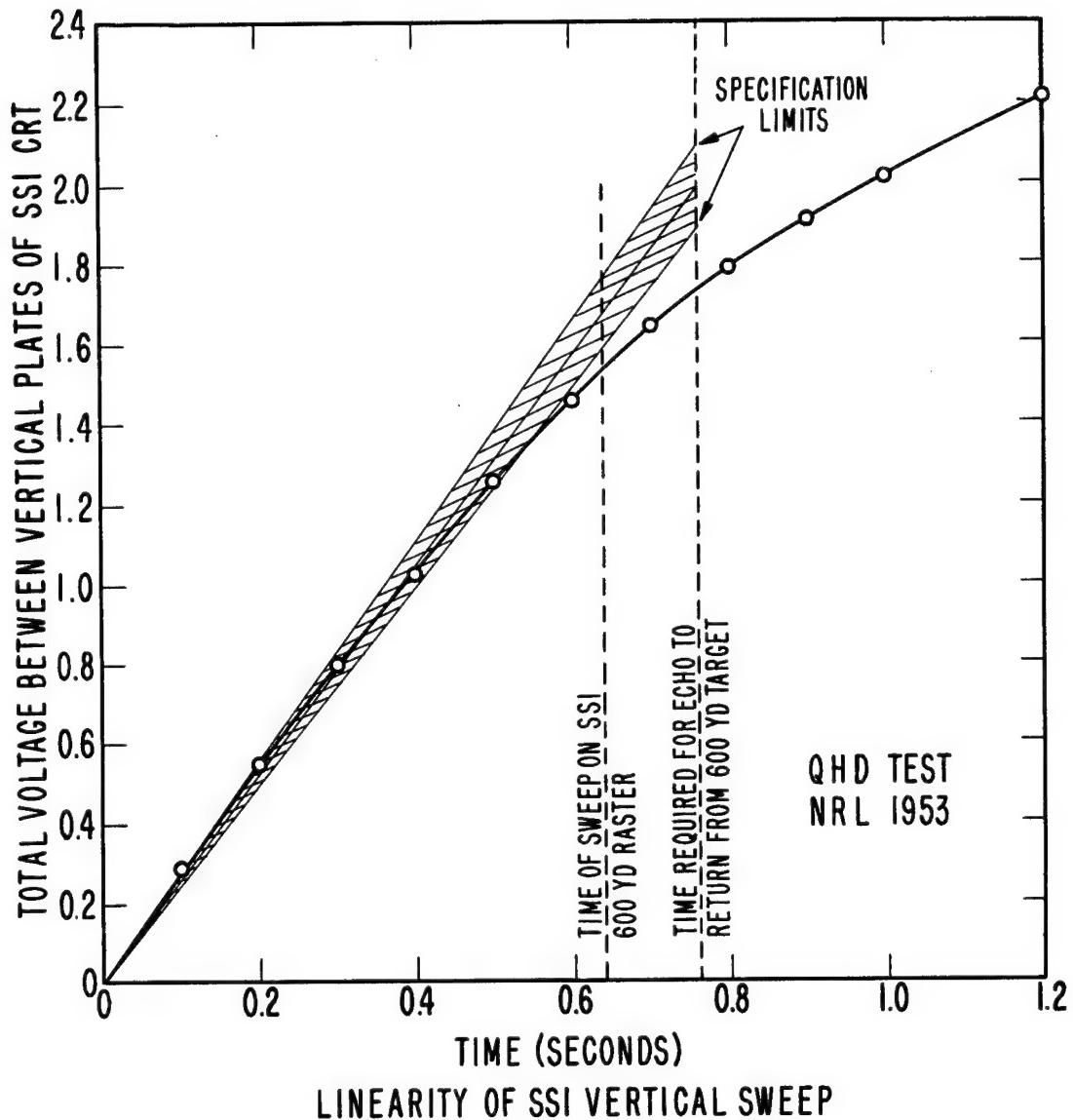


FIGURE 1

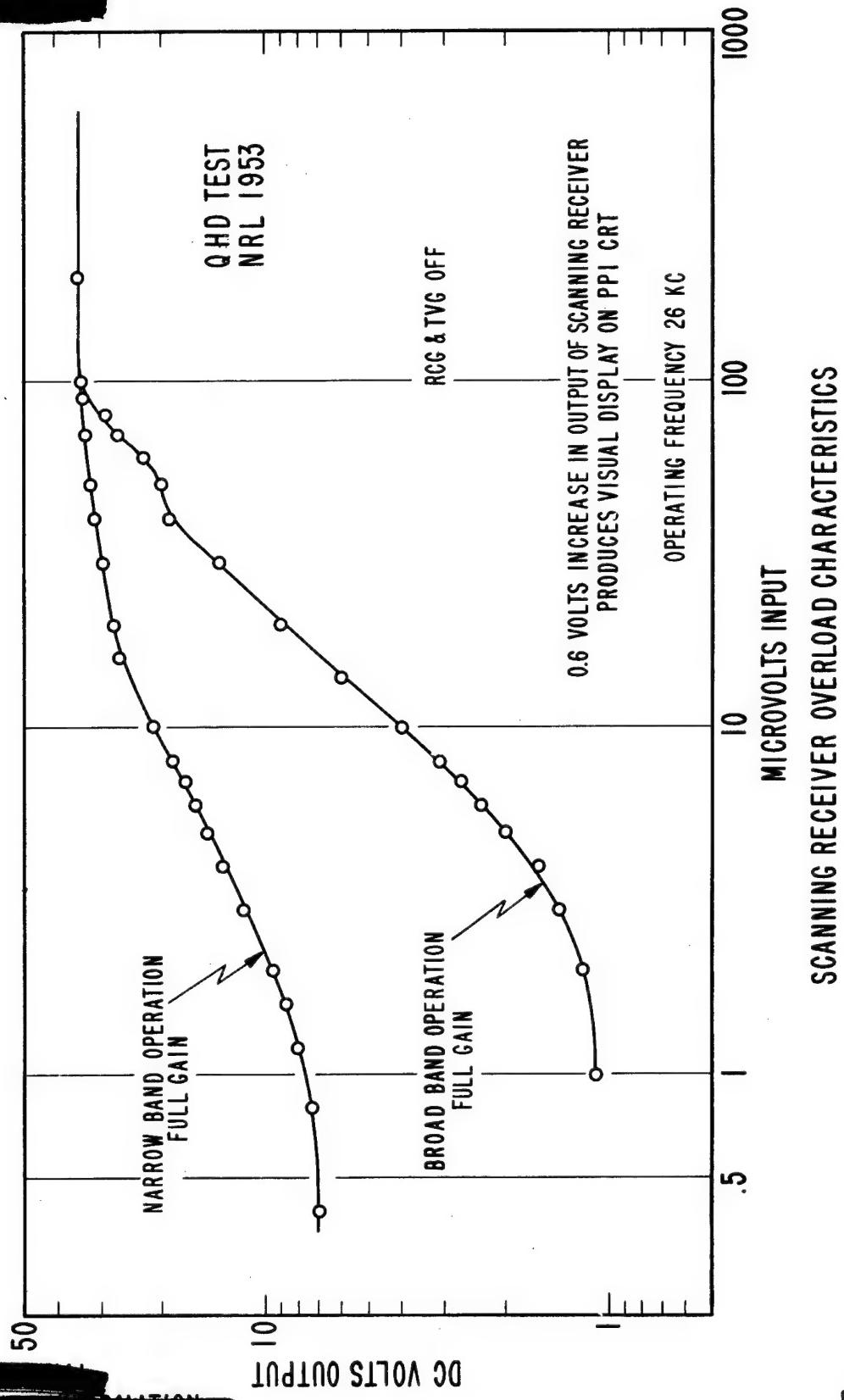


FIGURE 2

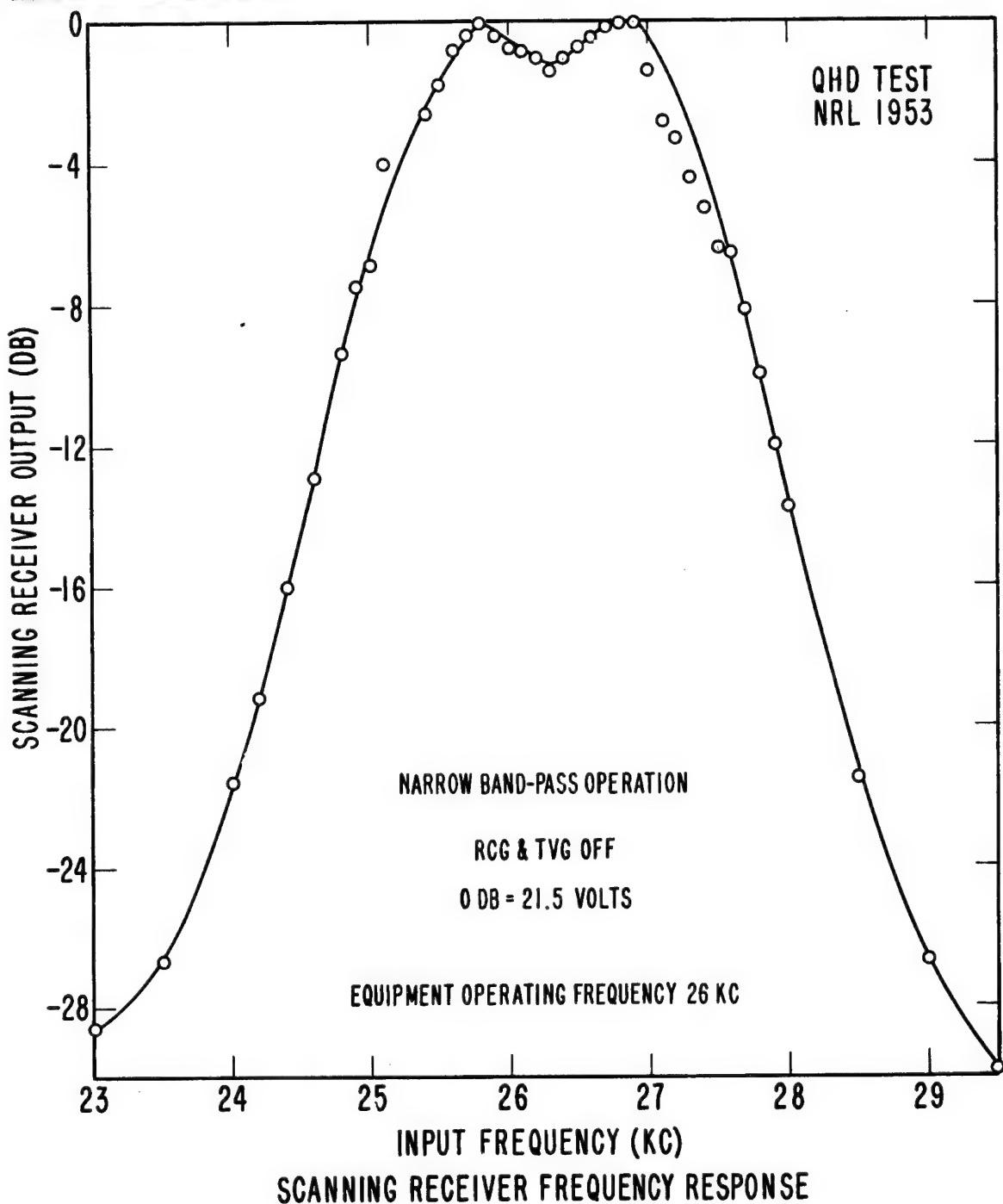


FIGURE 3

UNCLASSIFIED

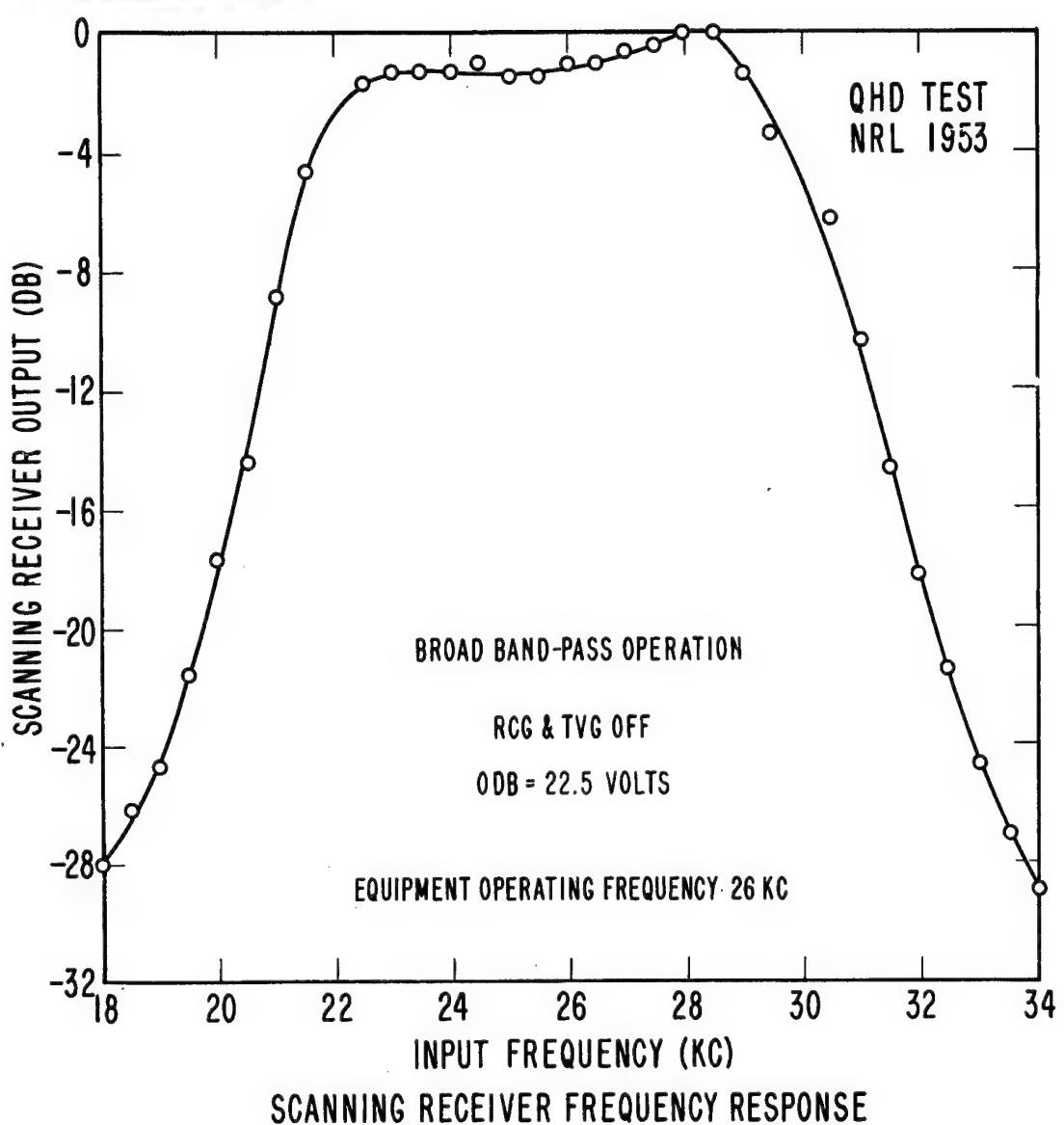


FIGURE 4

EFFECT OF TVG ON SCANNING RECEIVER GAIN

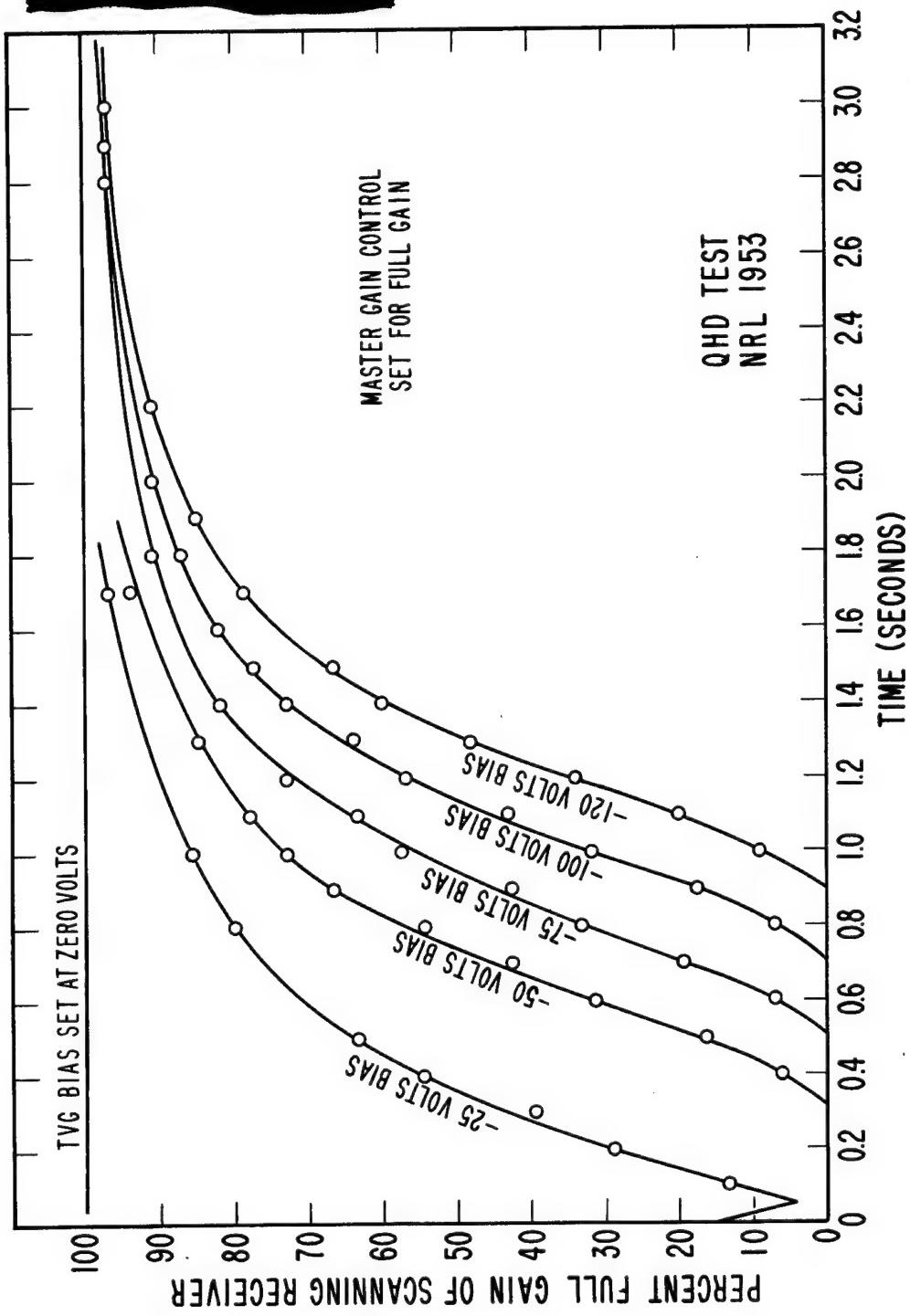
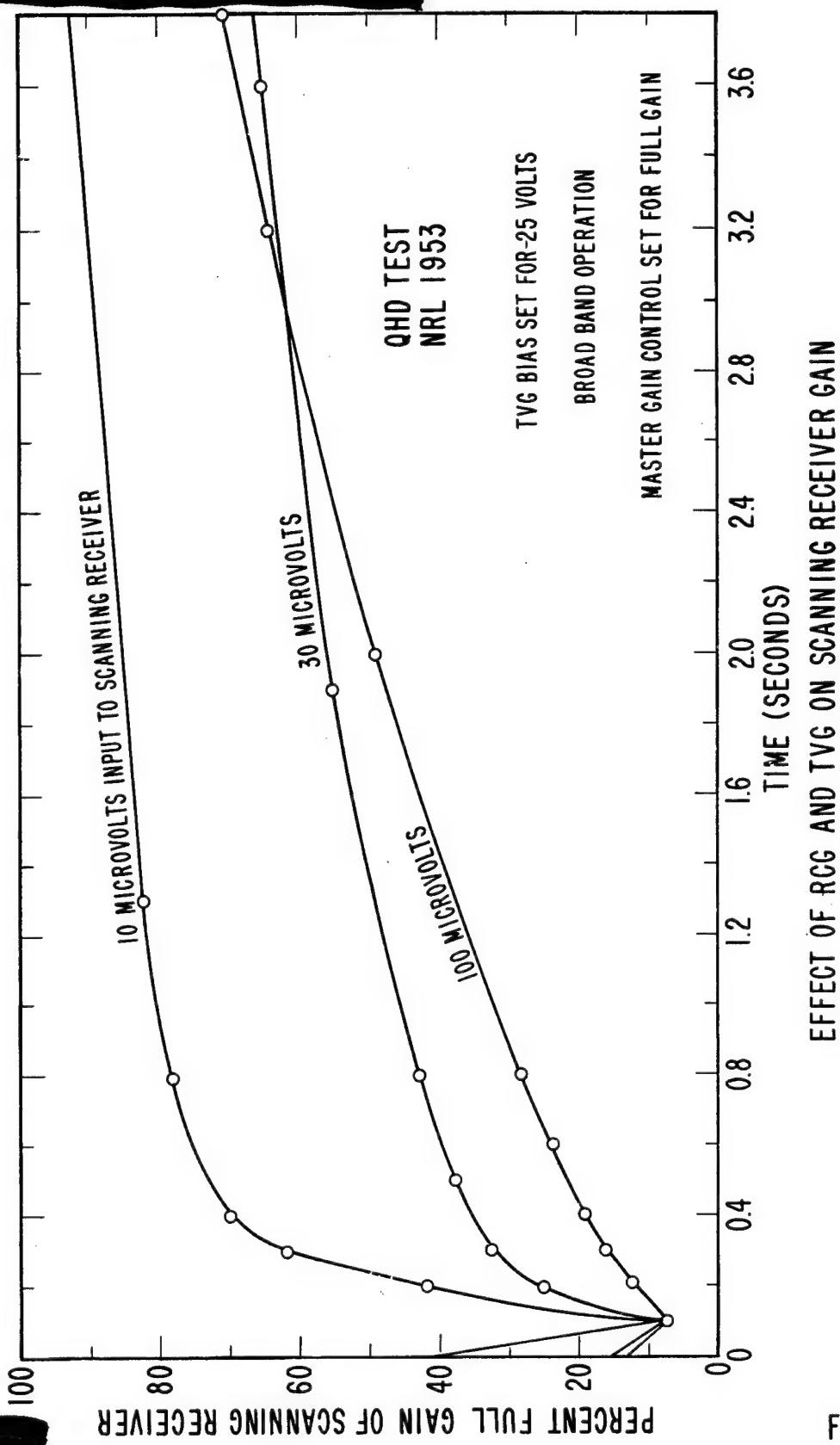


FIGURE 5



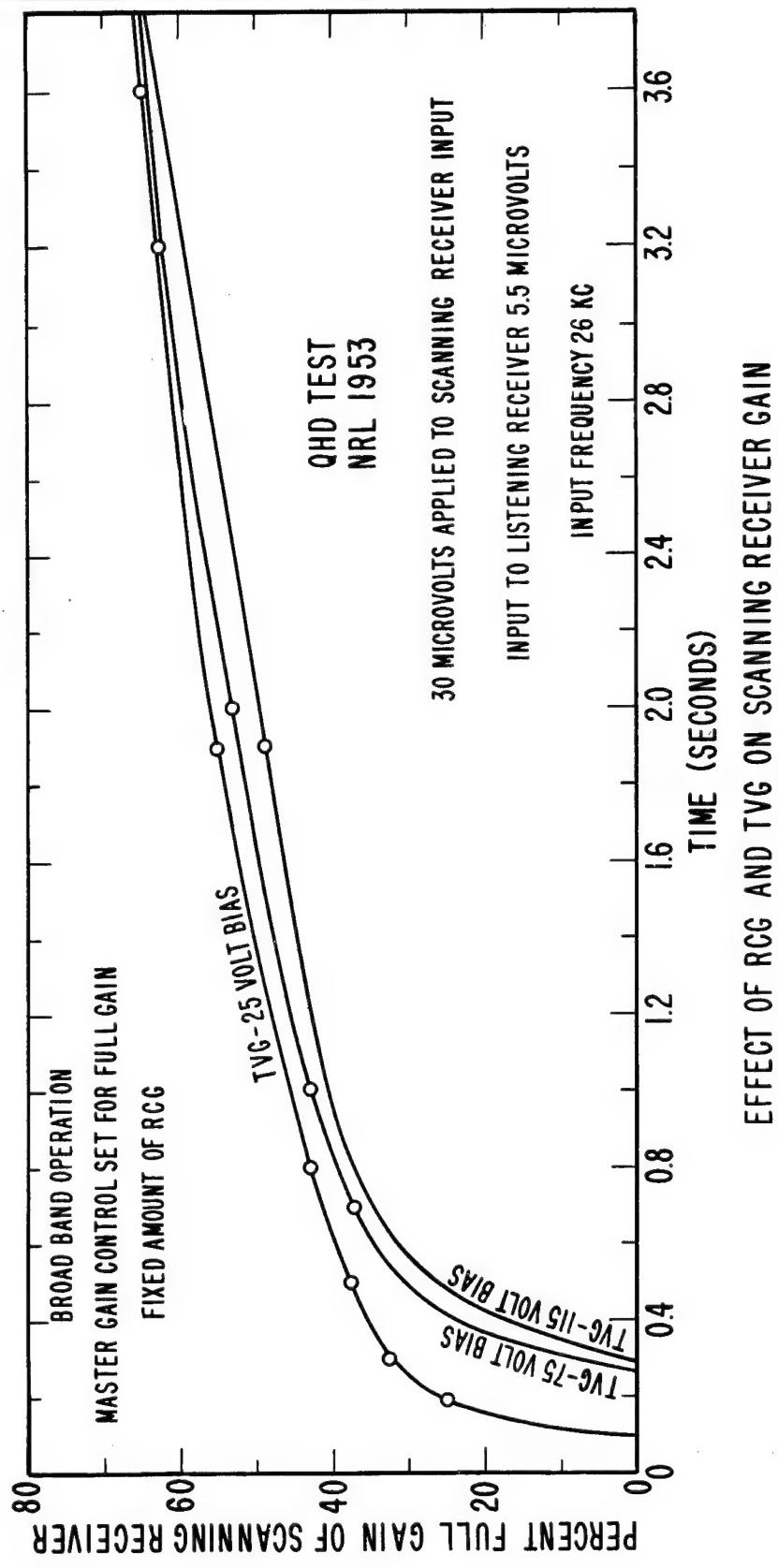


FIGURE 7

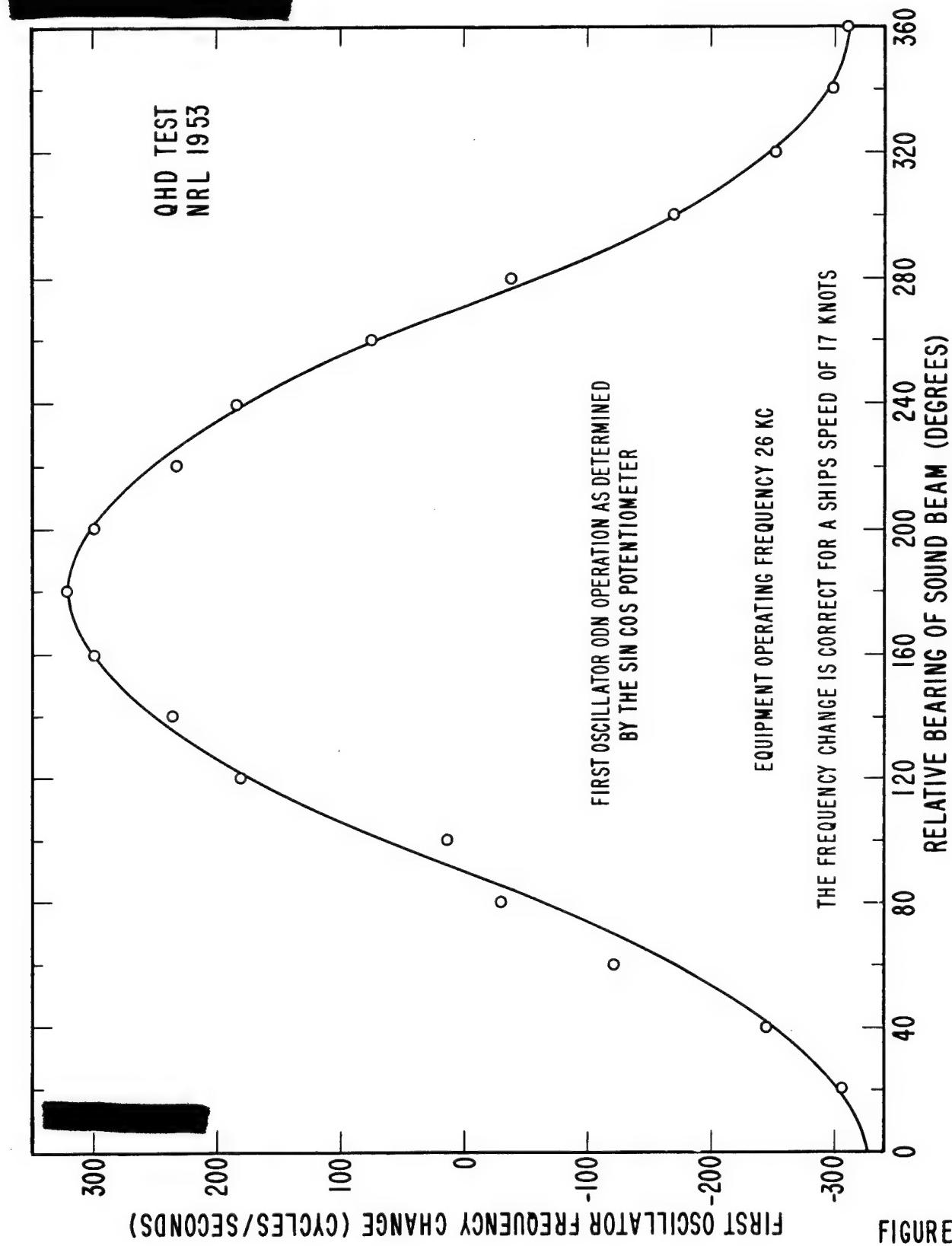


FIGURE 8

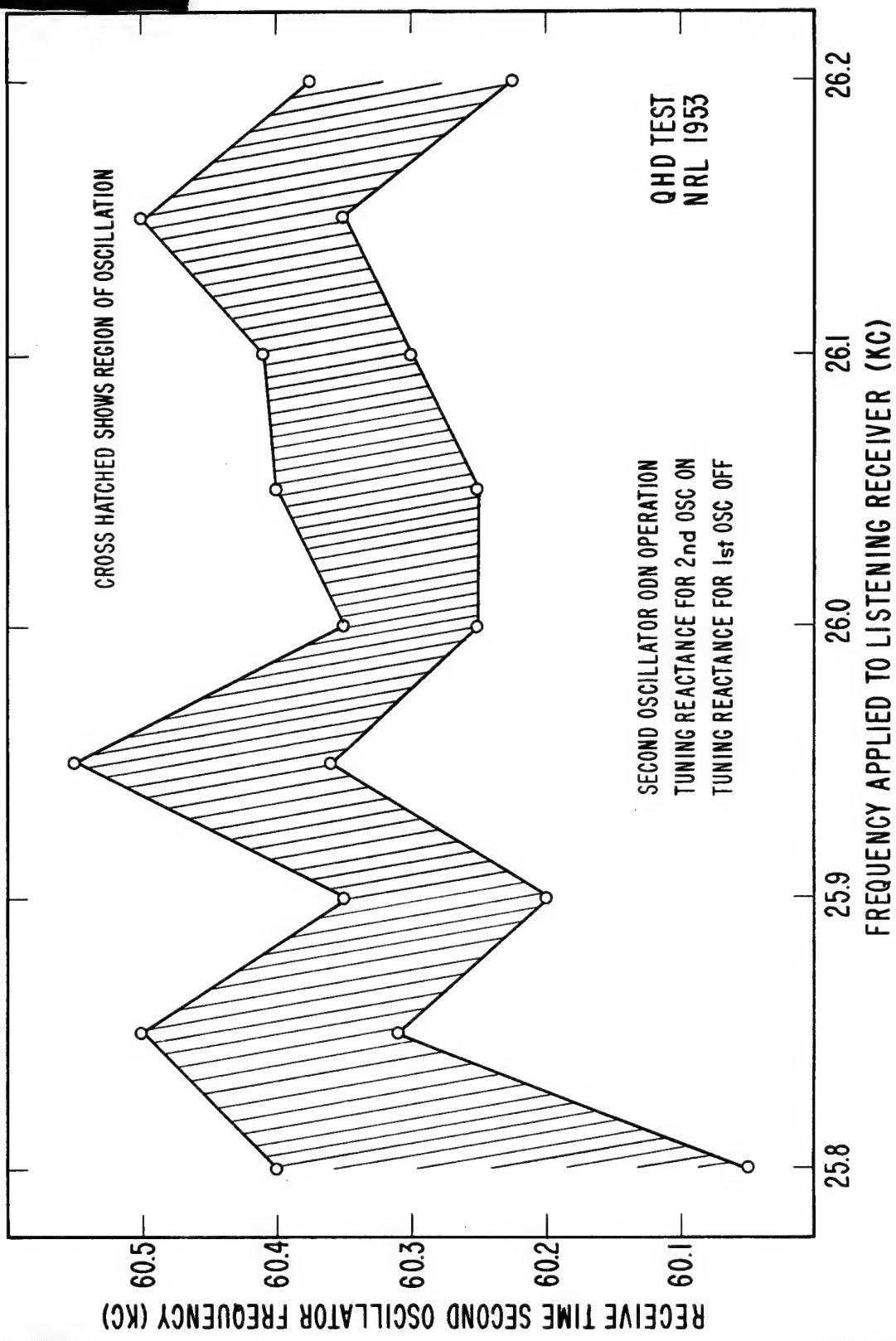


FIGURE 9

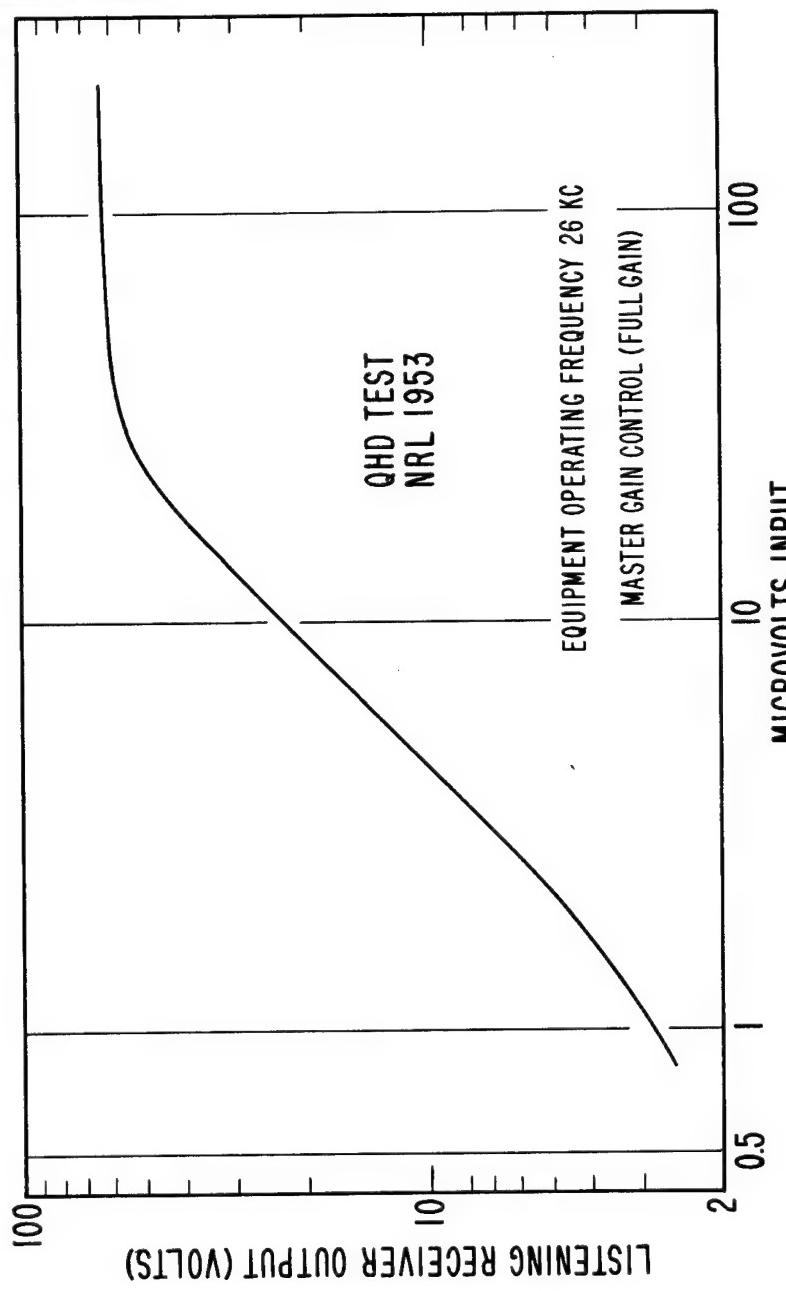


FIGURE 10

UNIVERSITÄT

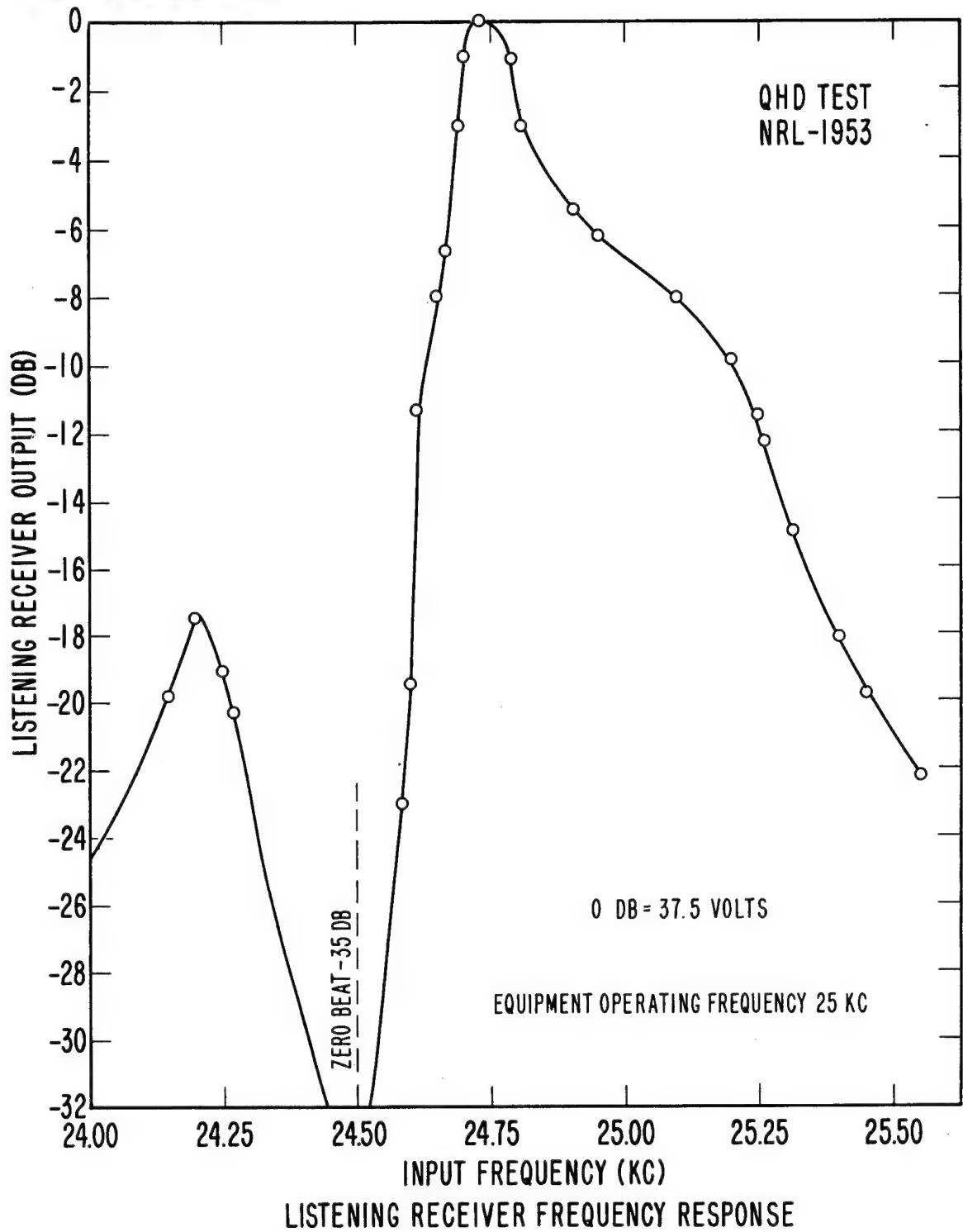


FIGURE 11

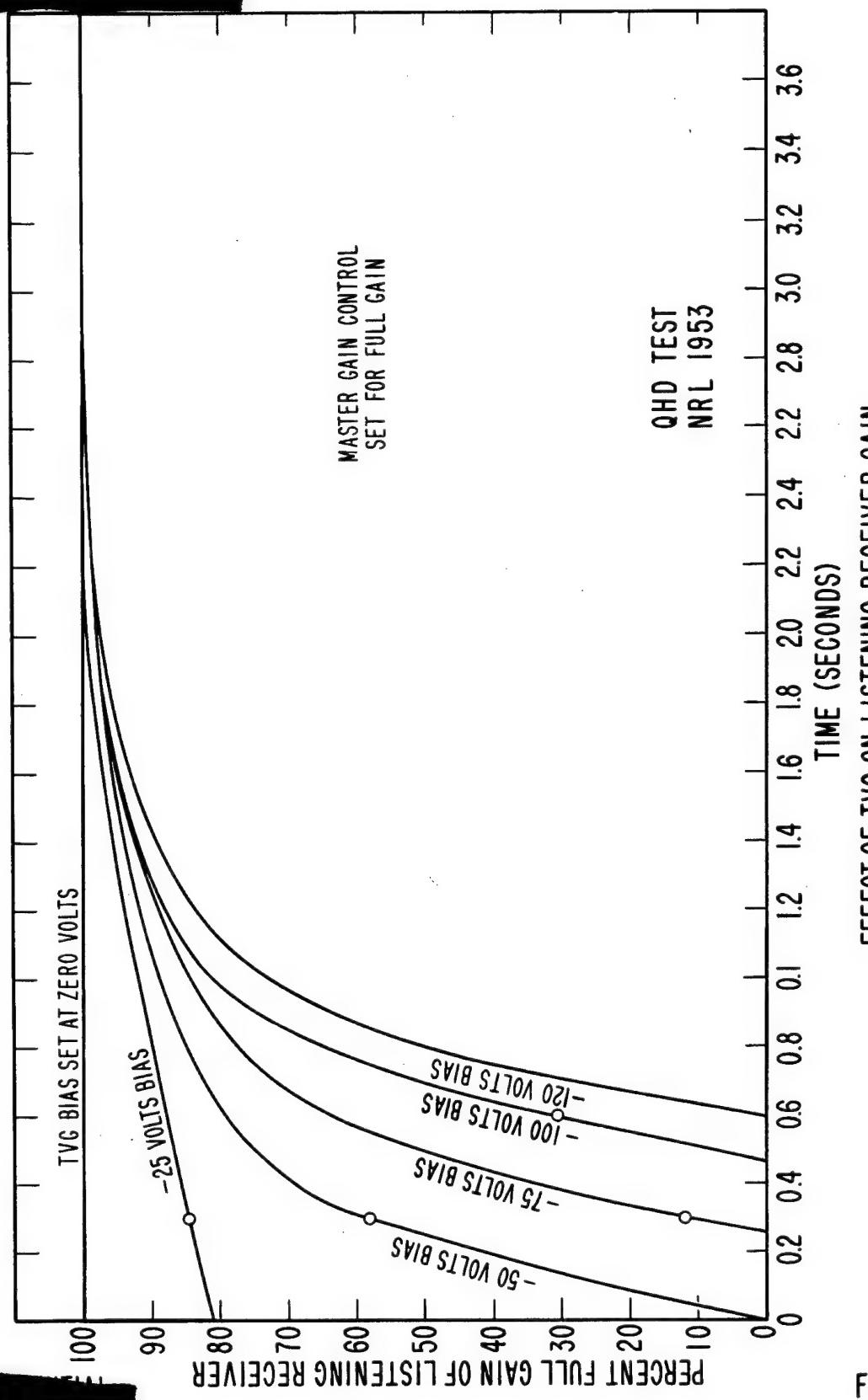


FIGURE 12

UNCLASSIFIED

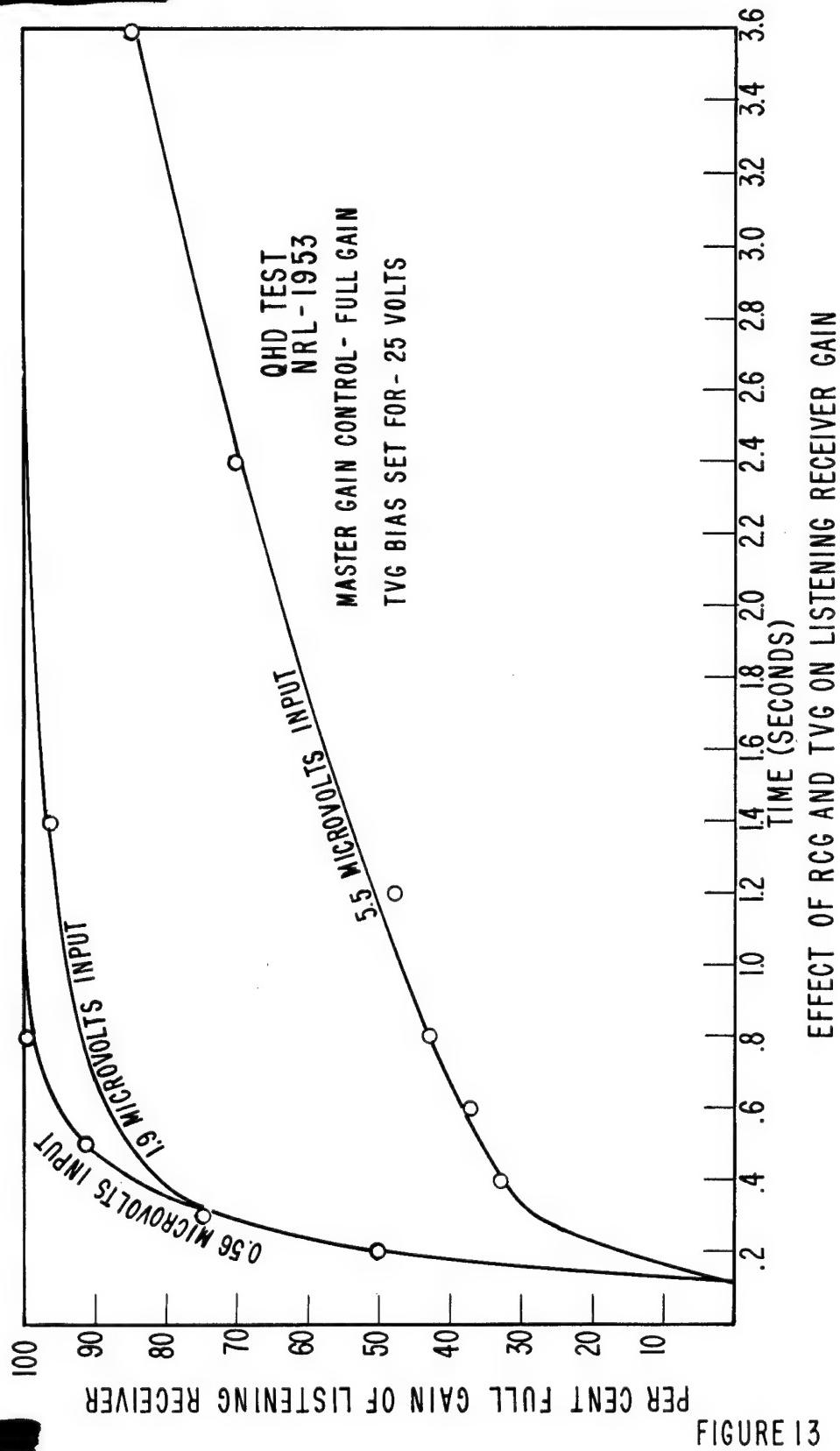


FIGURE 13

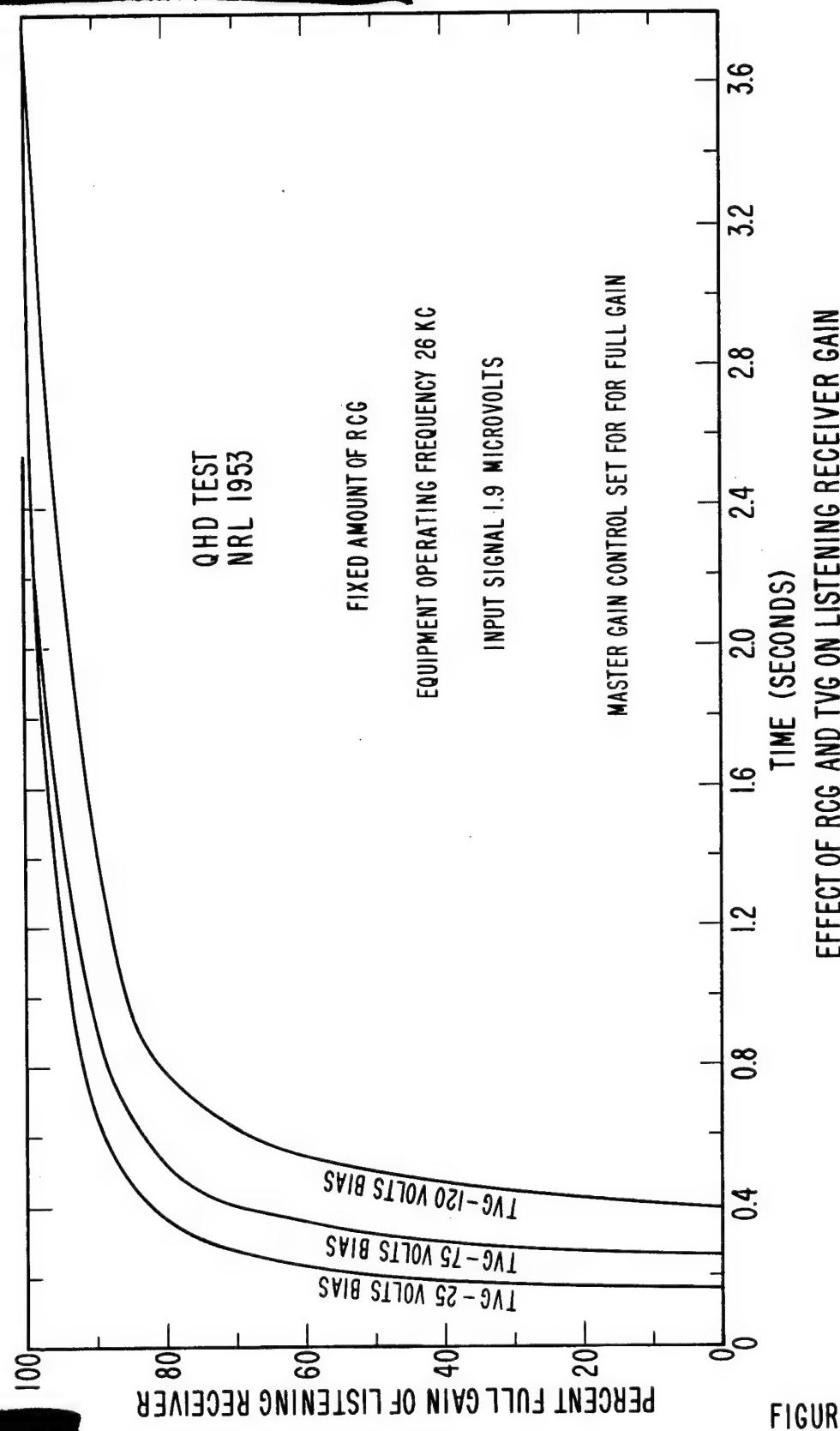


FIGURE 14

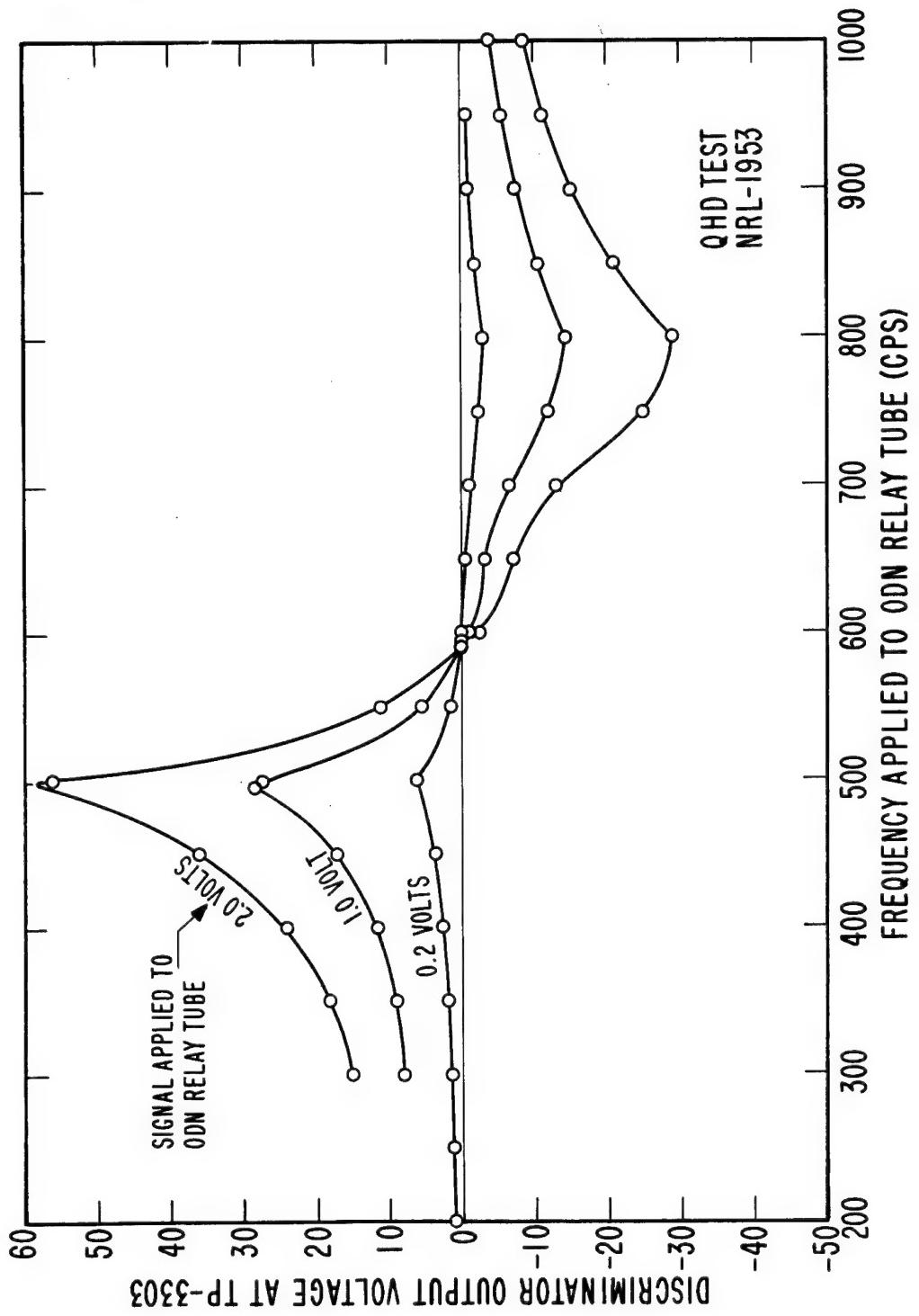
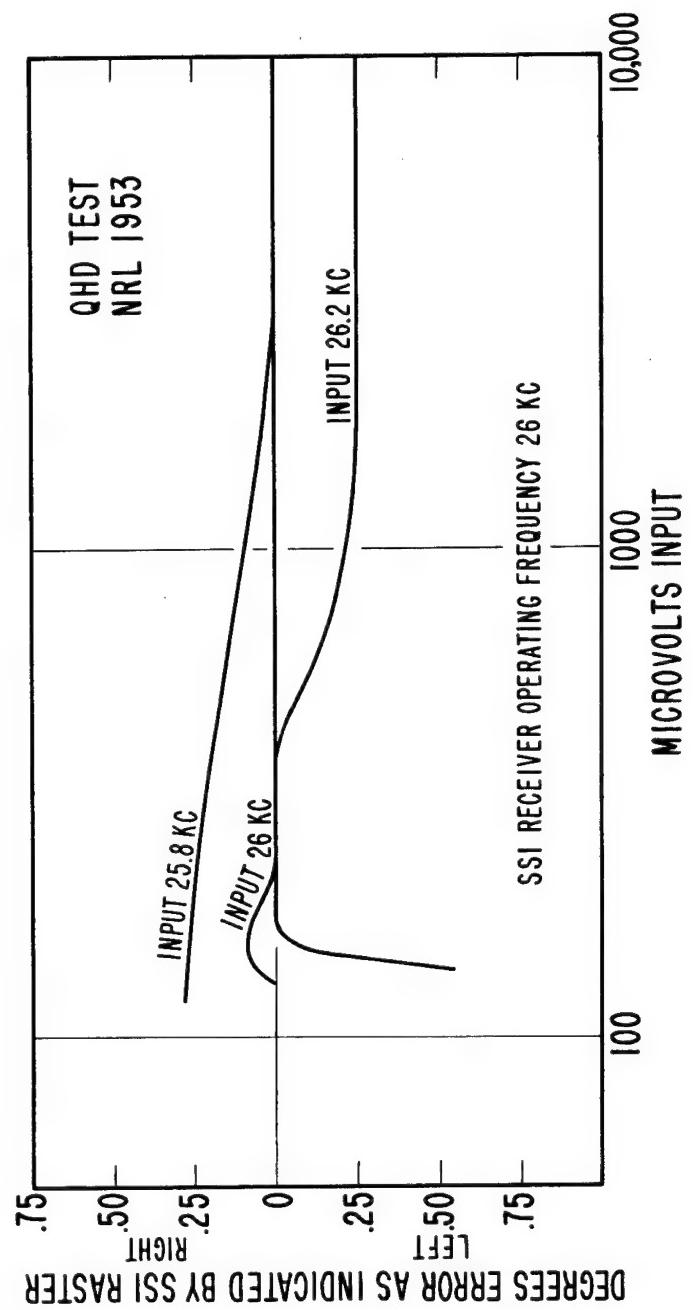


FIGURE 15



SSI RECEIVER OUTPUT VOLTAGE PHASE SHIFT WITH
CHANGE IN INPUT FREQUENCY AND AMPLITUDE

FIGURE 16

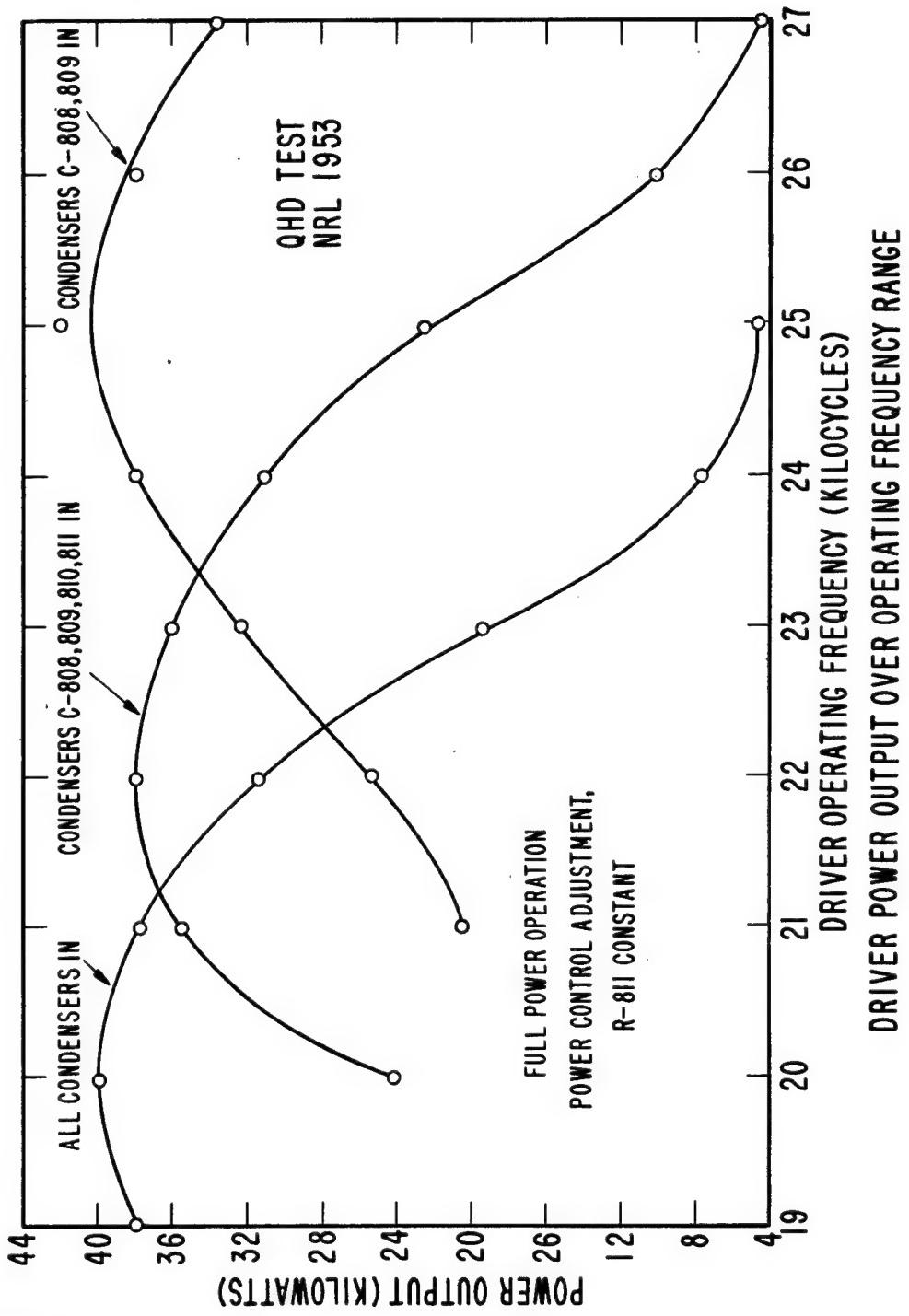
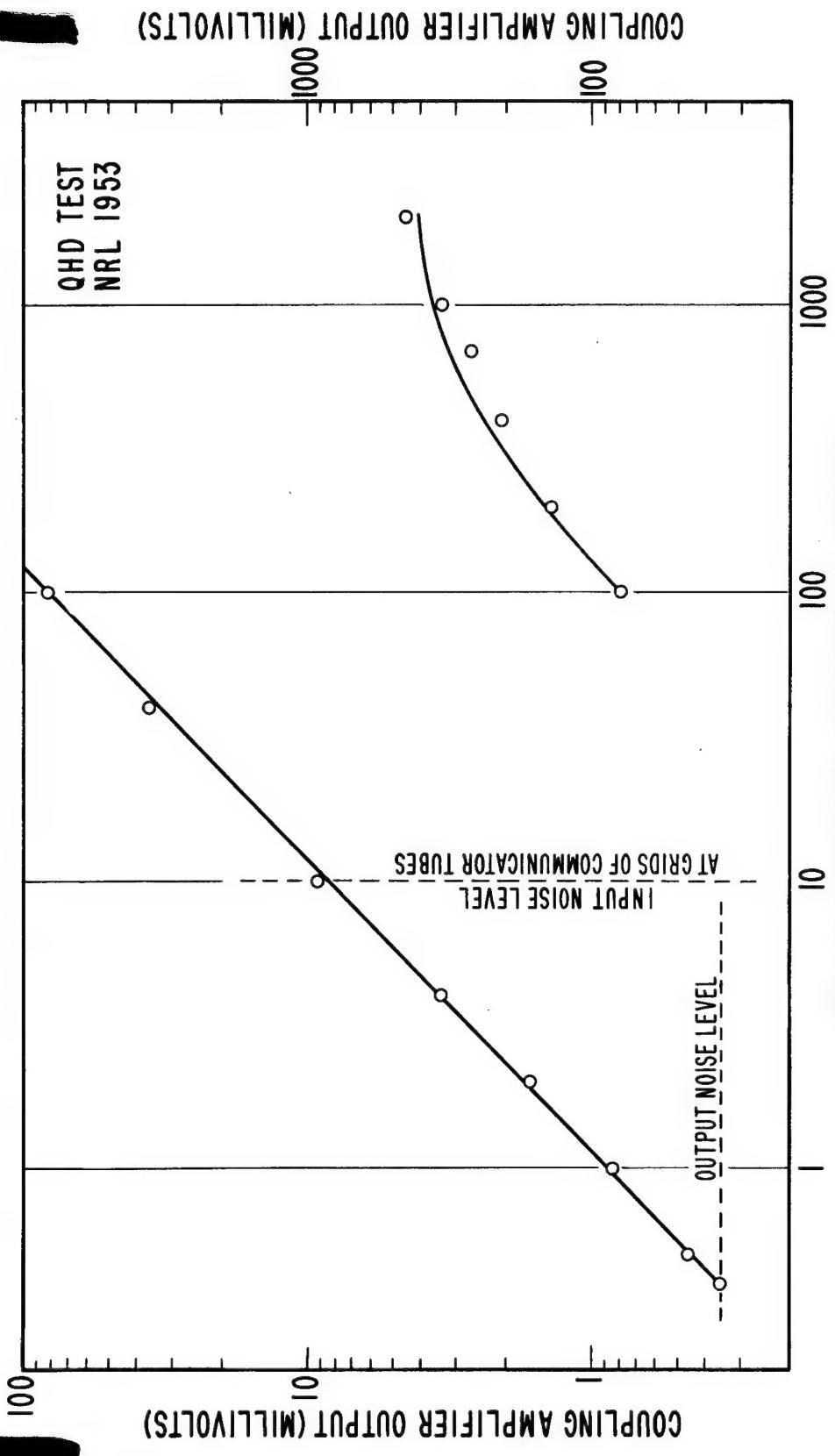


FIGURE 17

UNCLASSIFIED



COMMUTATOR TUBE OVERLOAD CHARACTERISTIC WITH THE COUPLING AMPLIFIER 26 KC

FIGURE 18

QHD TRANSDUCER - OPEN CIRCUIT VOLTAGE RESPONSE AND TRANSMITTING POWER RESPONSE OF INDIVIDUAL STANDARD STAVES AT 26 KC

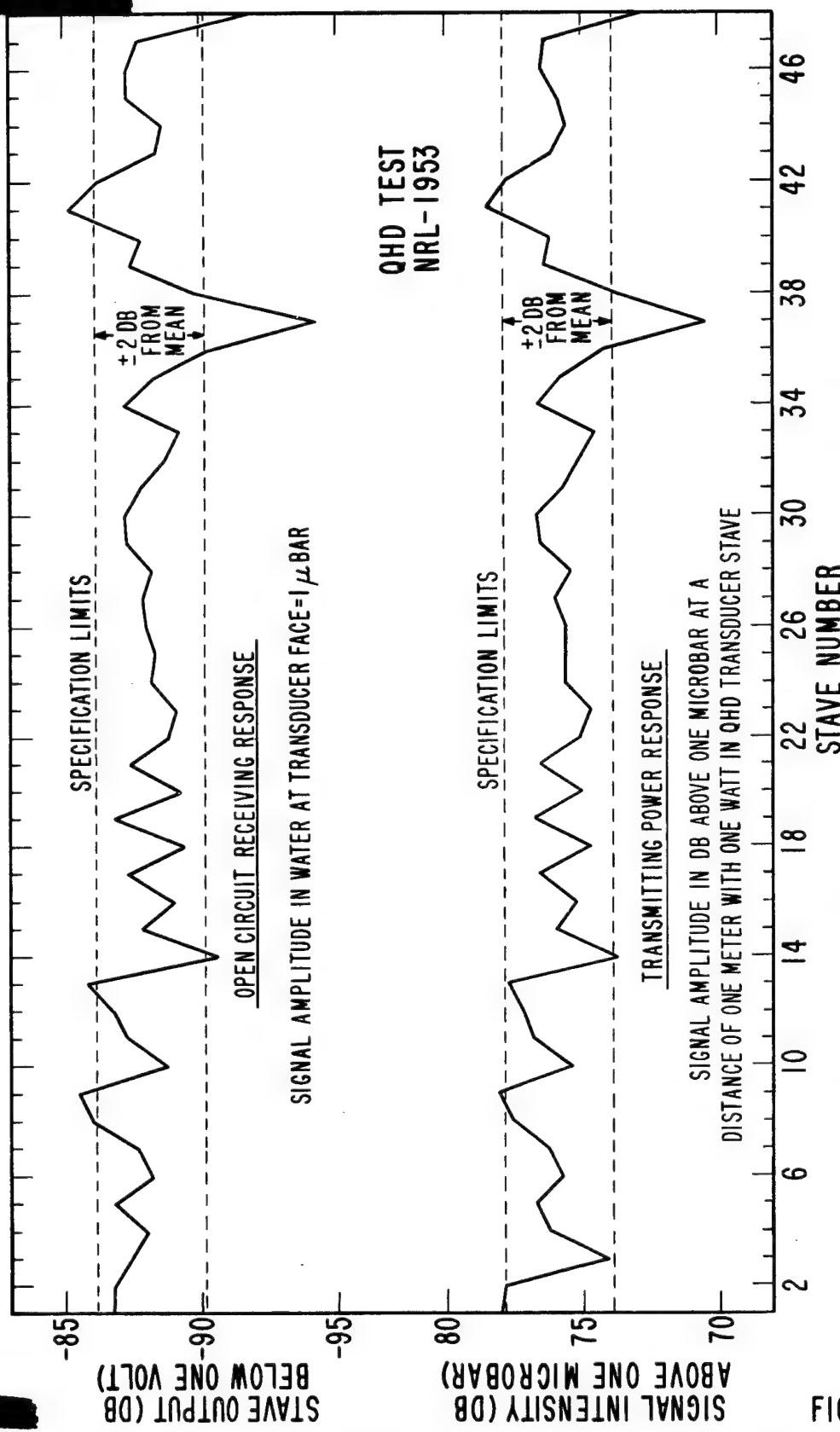


FIGURE 19

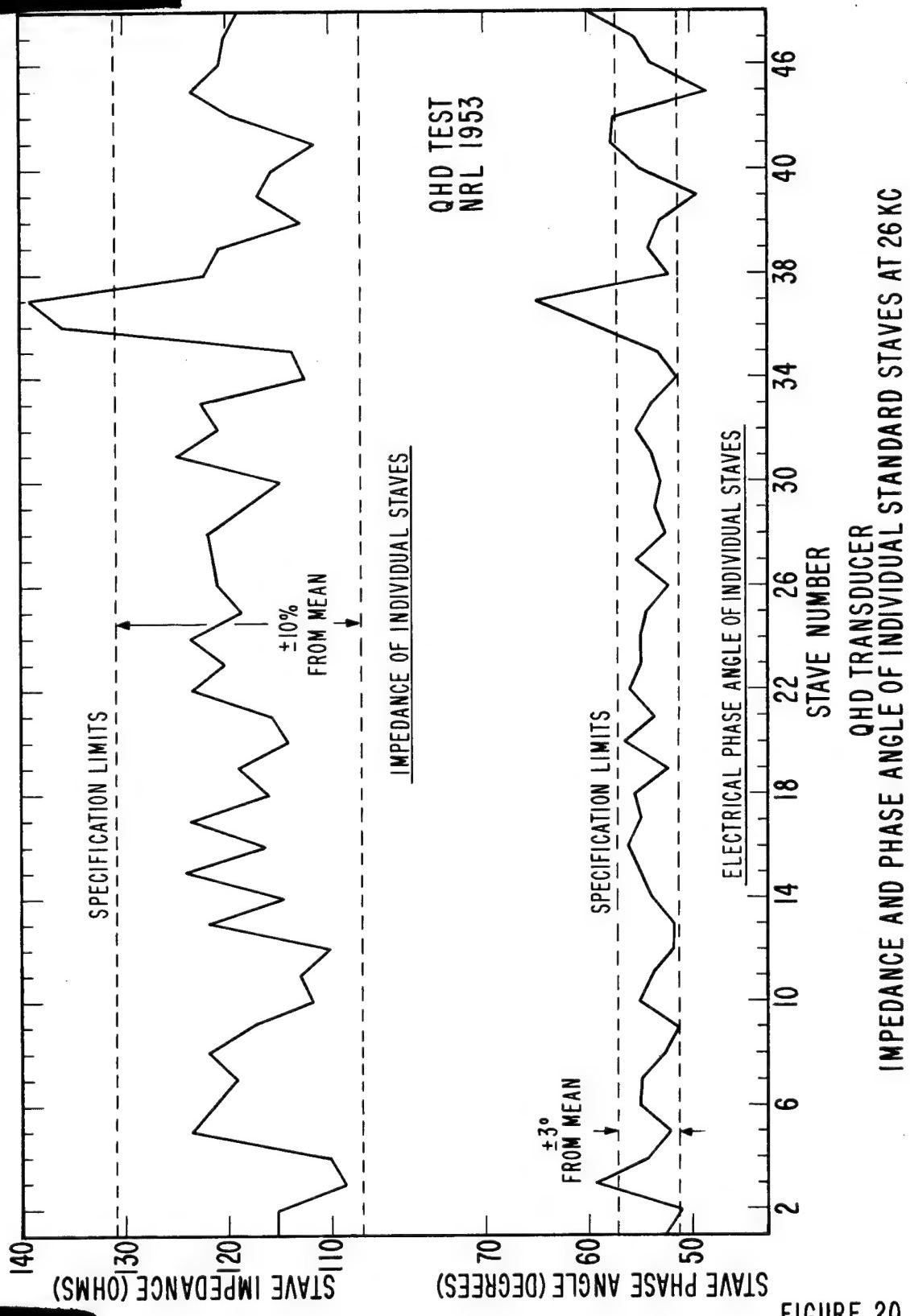
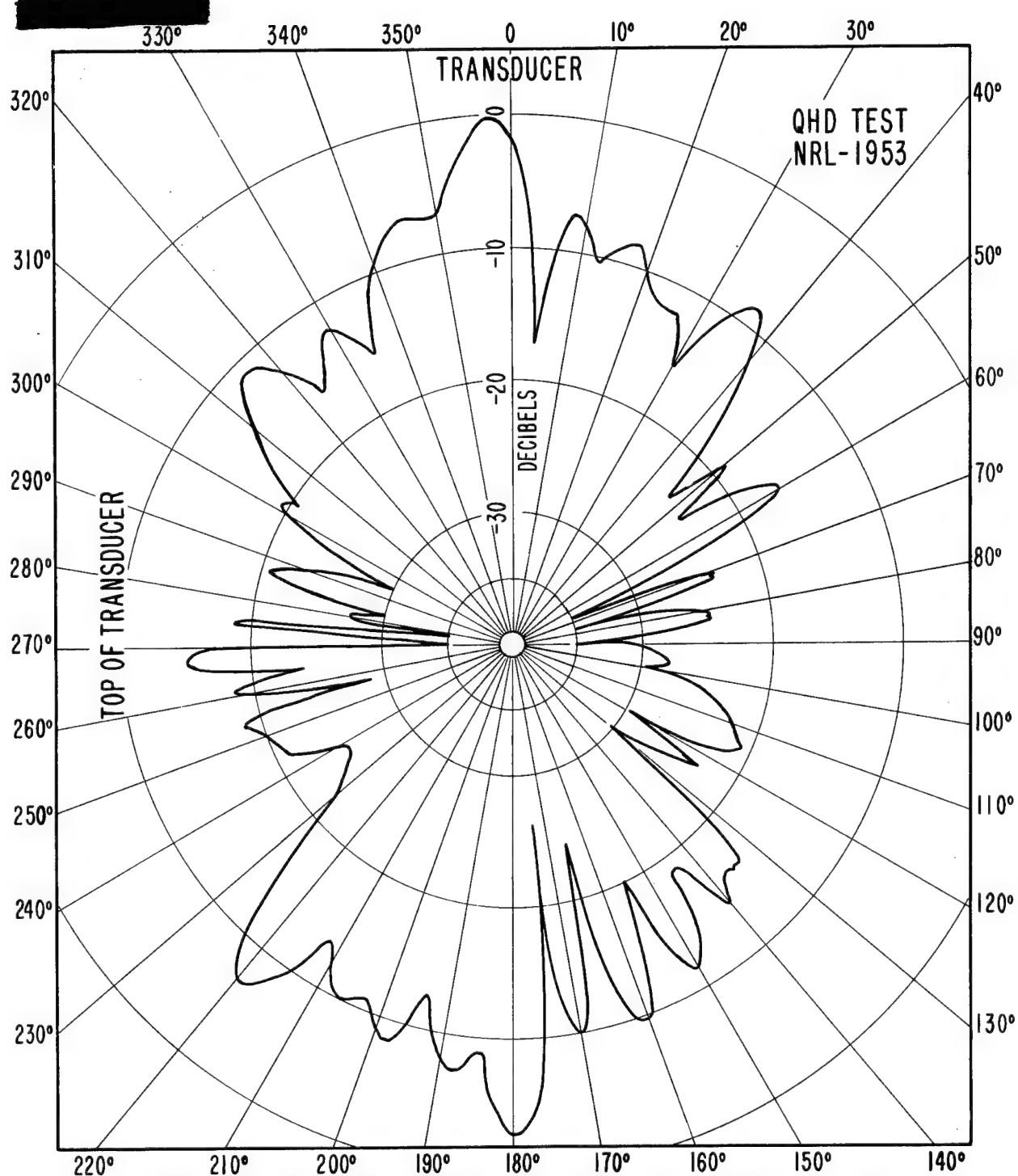


FIGURE 20



SOUND RADIATION PATTERN OF MCC OPERATION, VERTICAL PLANE
TRANSDUCER WIRED ACCORDING TO TERMINAL NUMBERS
TERMINALS 49 TO 49 AND 50 TO 50 ON BOARD E 1905

FIGURE 21

UNCLASSIFIED

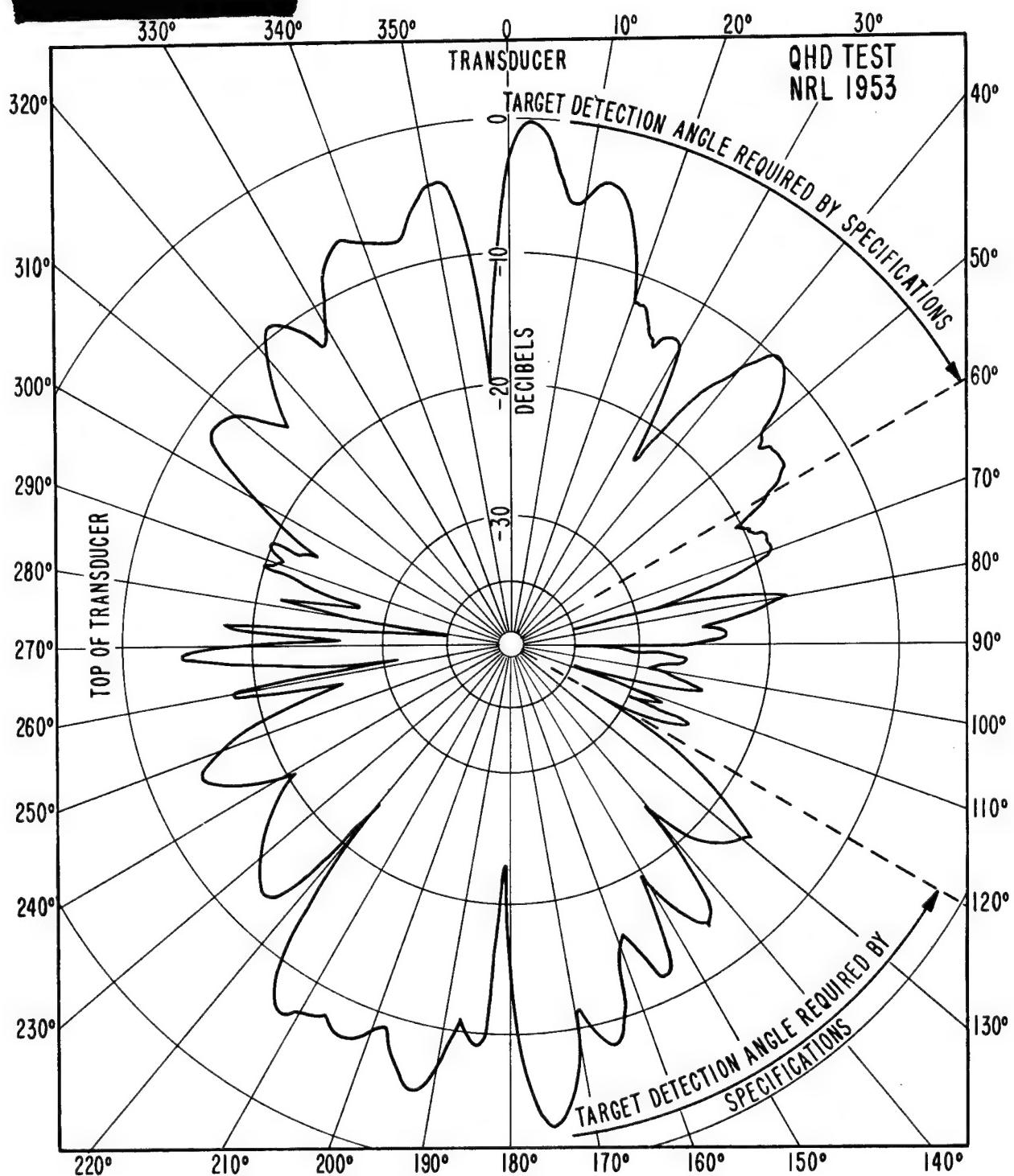
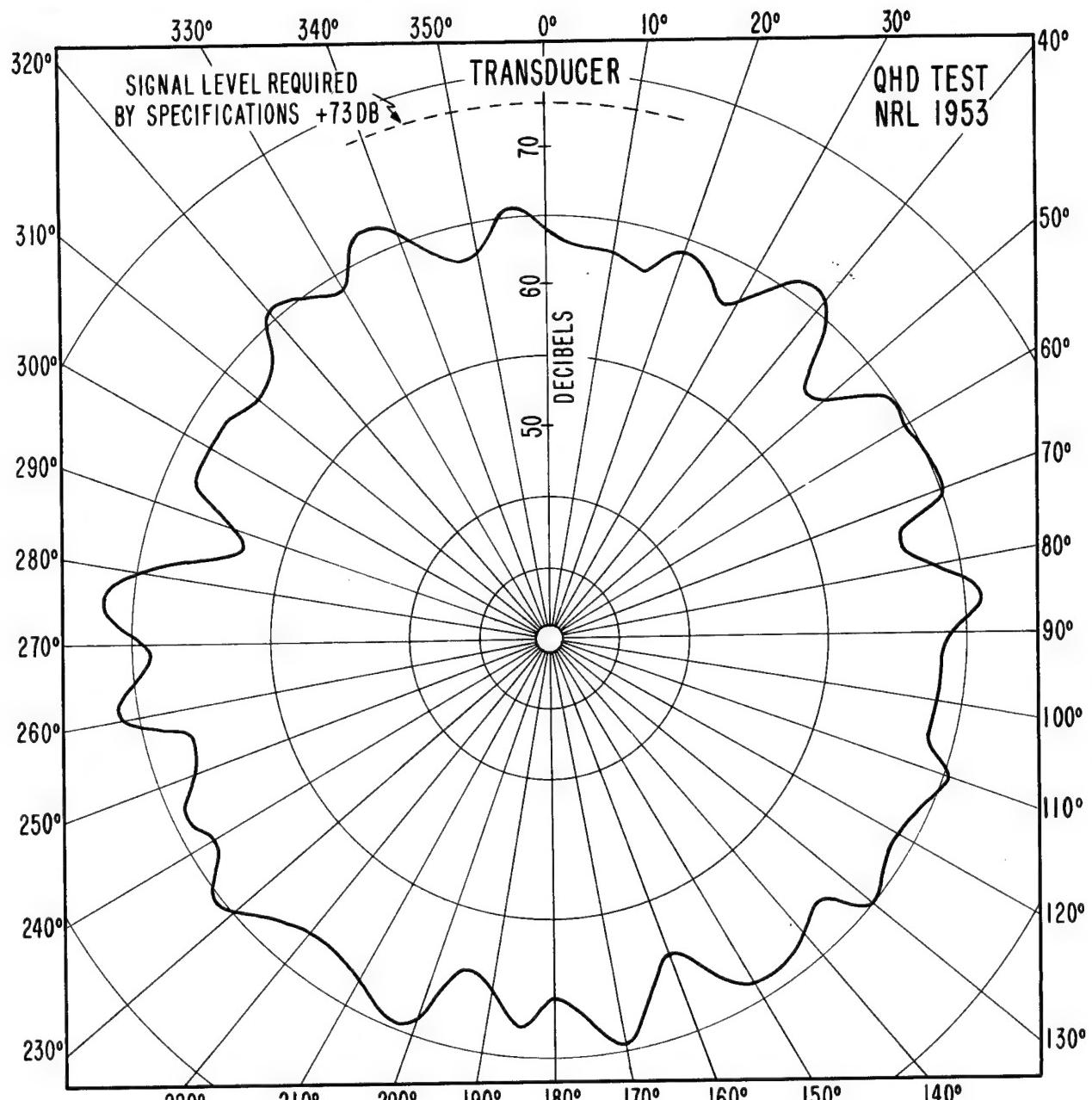


FIGURE 22



TRANSMITTING RESPONSE OF MCC SECTION HORIZONTAL PLANE
IN DECIBELS ABOVE ONE MICROBAR AT A DISTANCE OF
ONE METER WITH ONE WATT IN THE QHD TRANSDUCER

UNCLASSIFIED

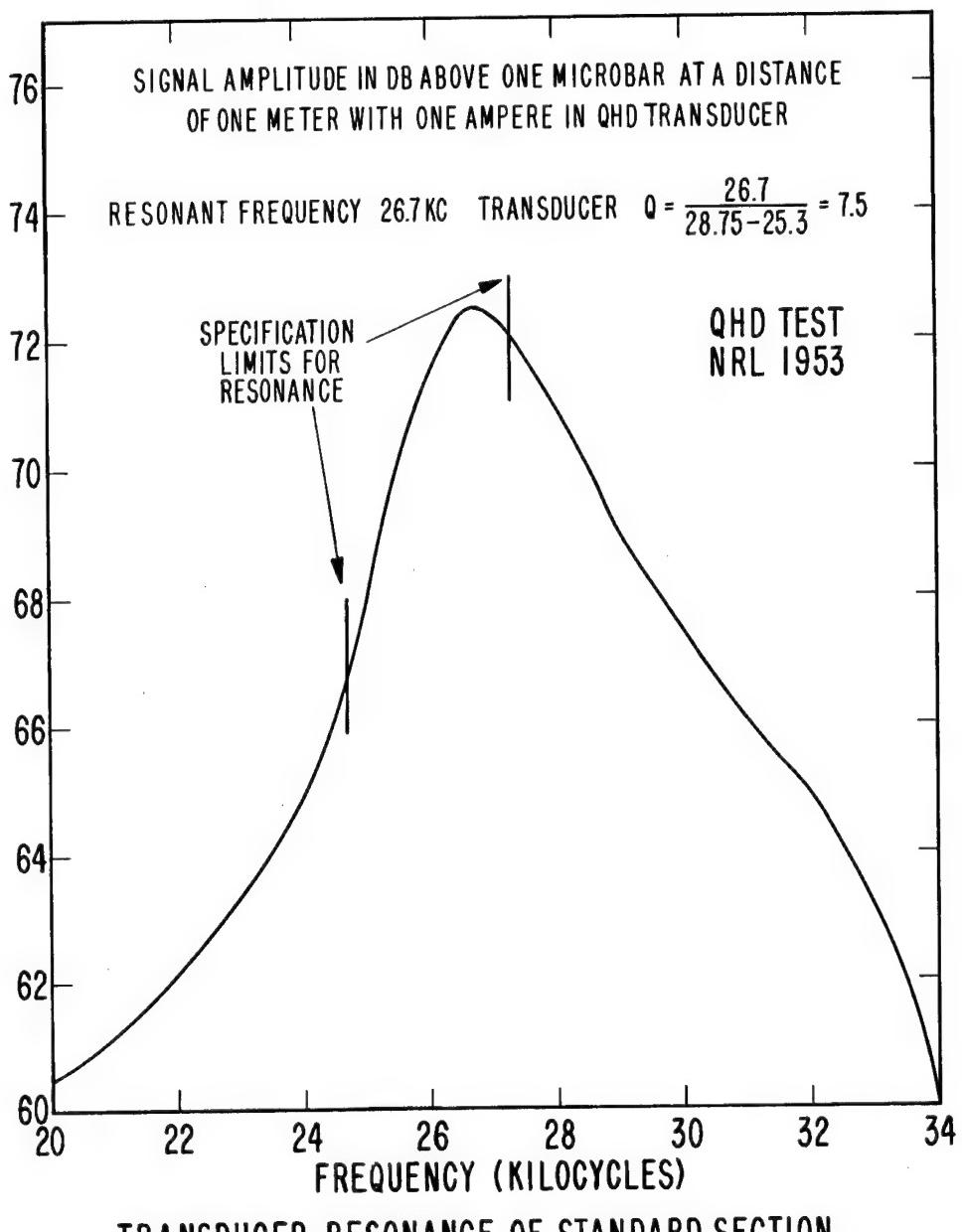
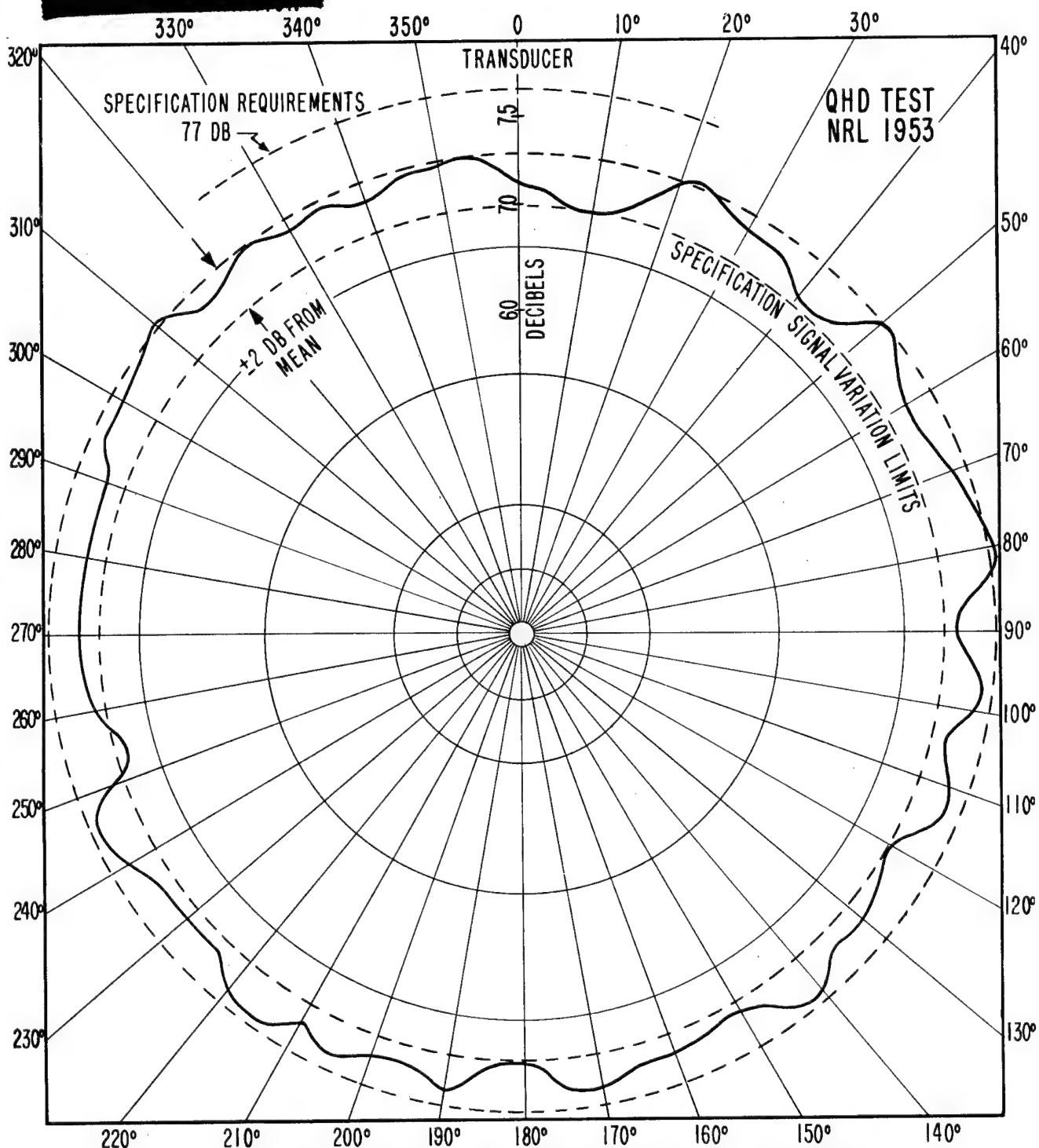


FIGURE 24



TRANSMITTING RESPONSE OF STANDARD SECTION IN DECIBELS
ABOVE ONE MICROBAR AT A DISTANCE OF ONE METER
WITH ONE WATT INPUT TO THE QHD TRANSDUCER

FIGURE 25

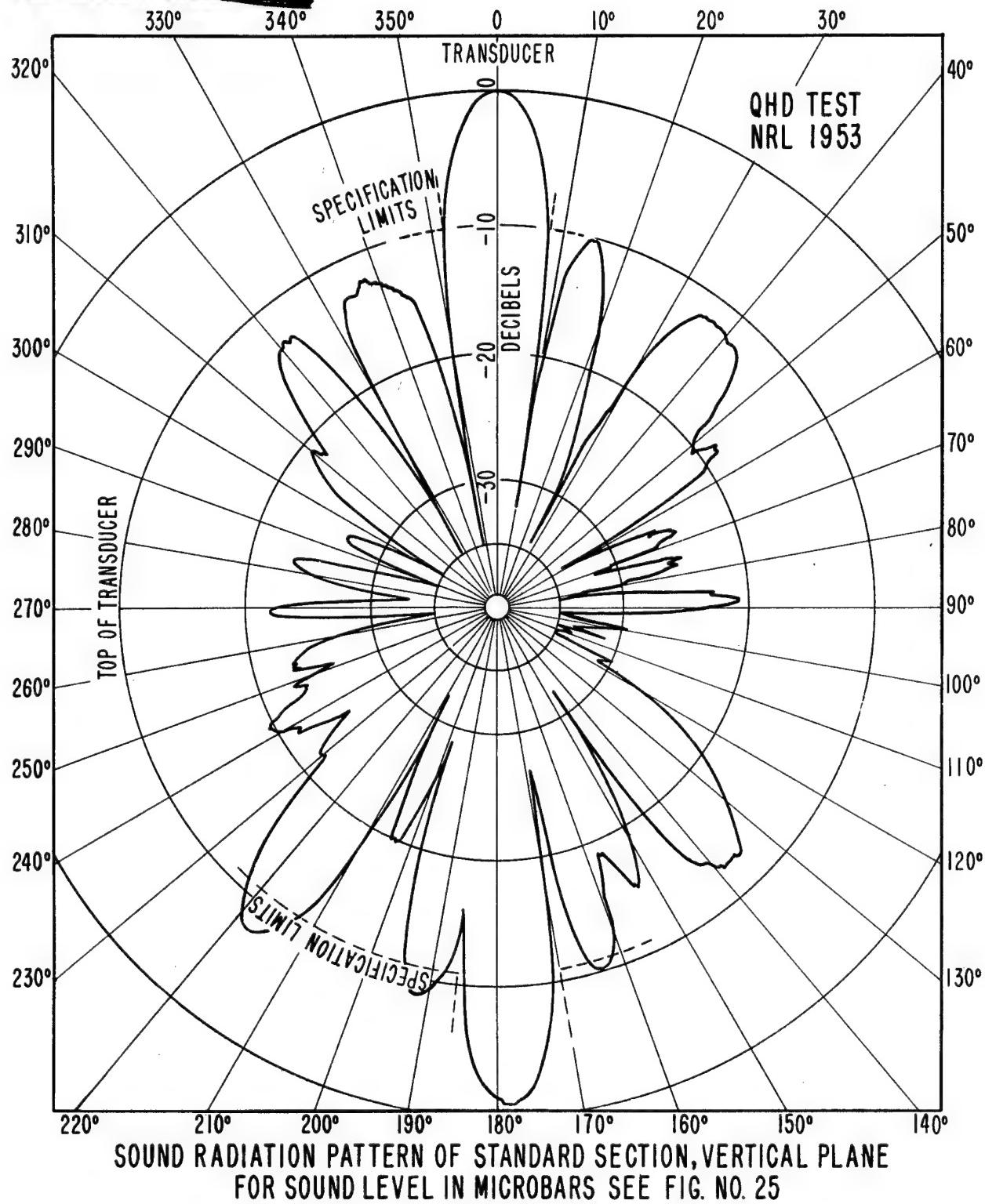
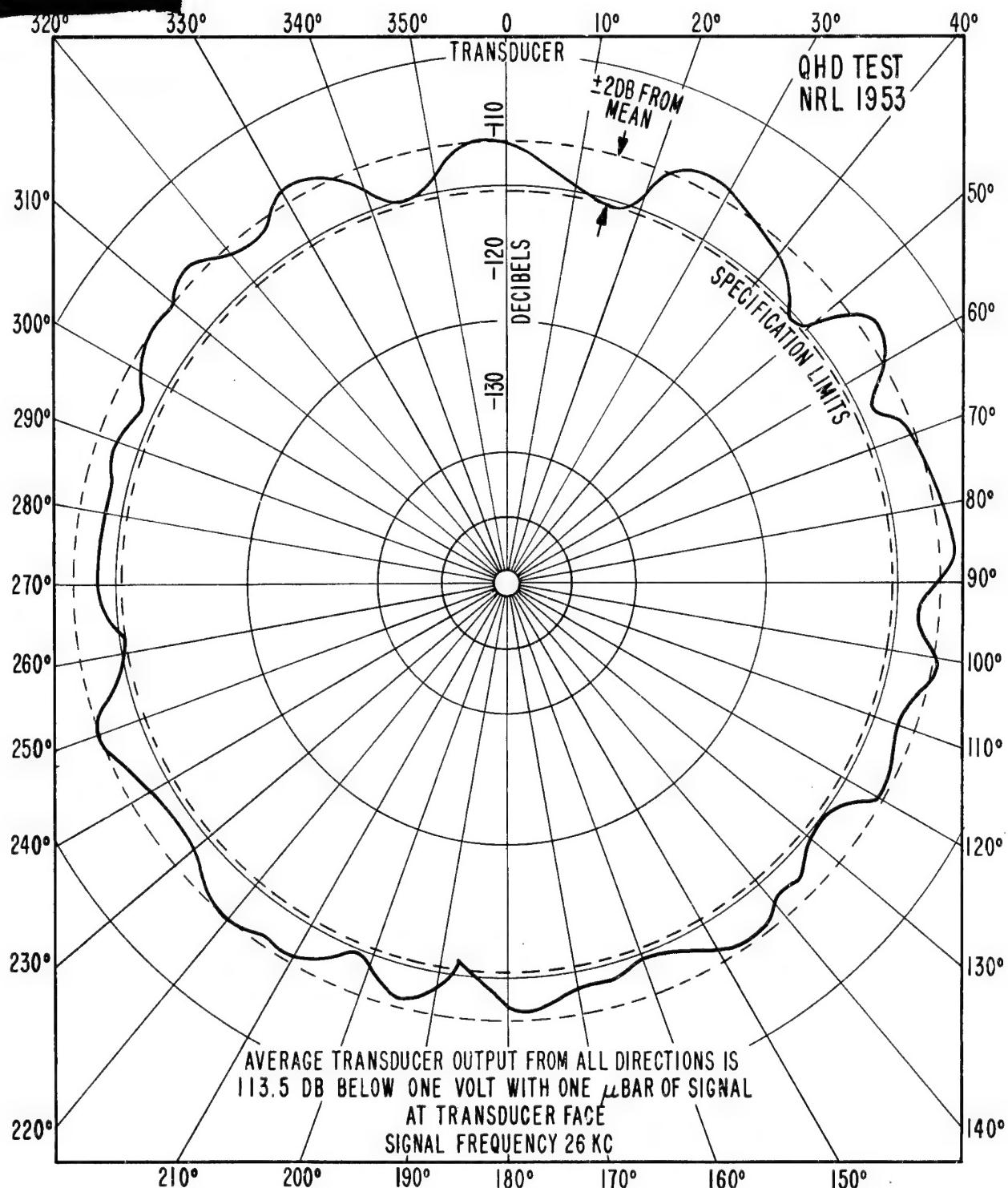


FIGURE 26

UNCLASSIFIED



HORIZONTAL RECEIVING BEAM PATTERN
ALL STAVES CONNECTED IN PARALLEL AIDING OPEN CIRCUIT

FIGURE 27

UNCLASSIFIED

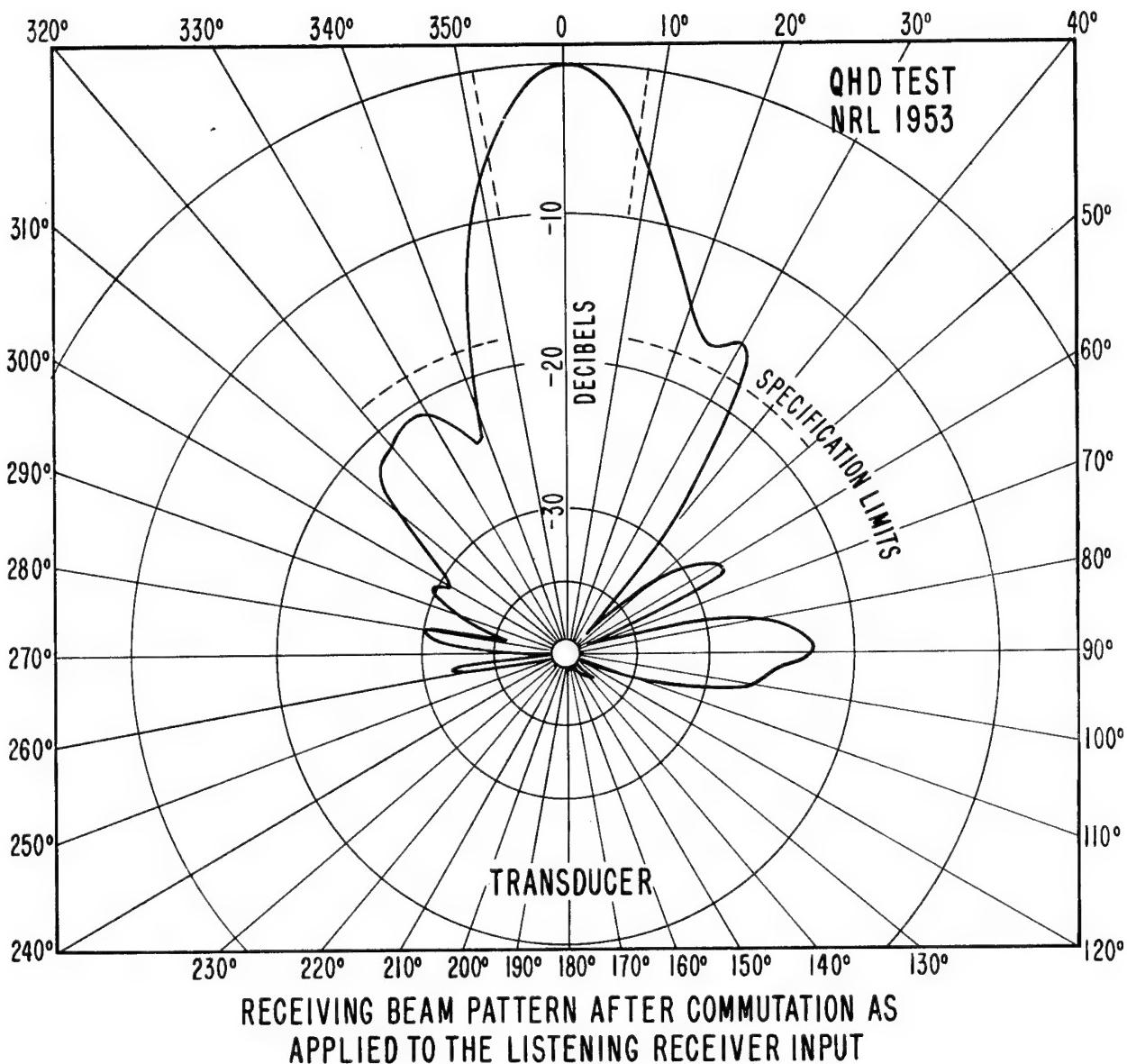


FIGURE 28

UNCLASSIFIED

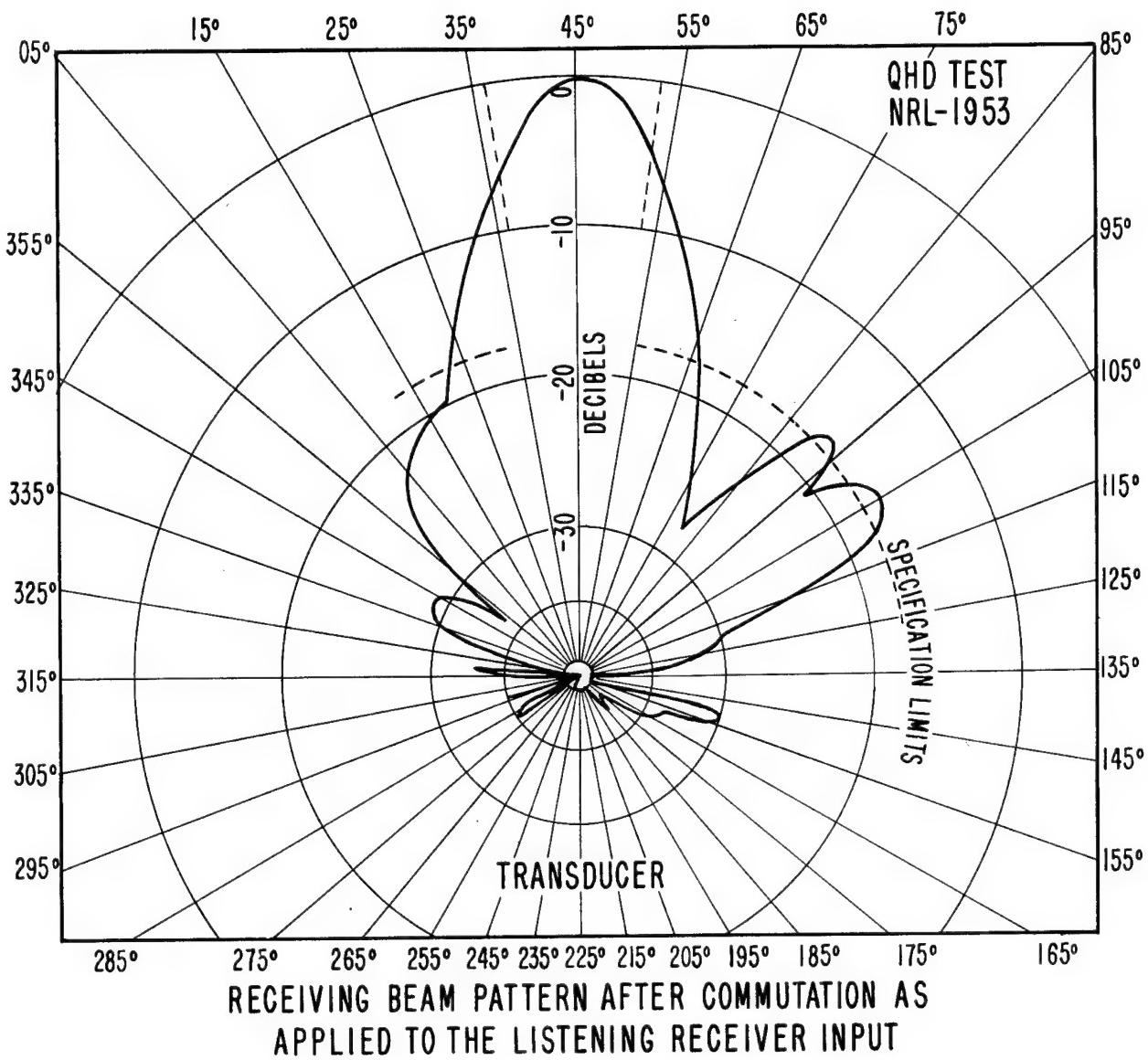


FIGURE 29

UNCLASSIFIED

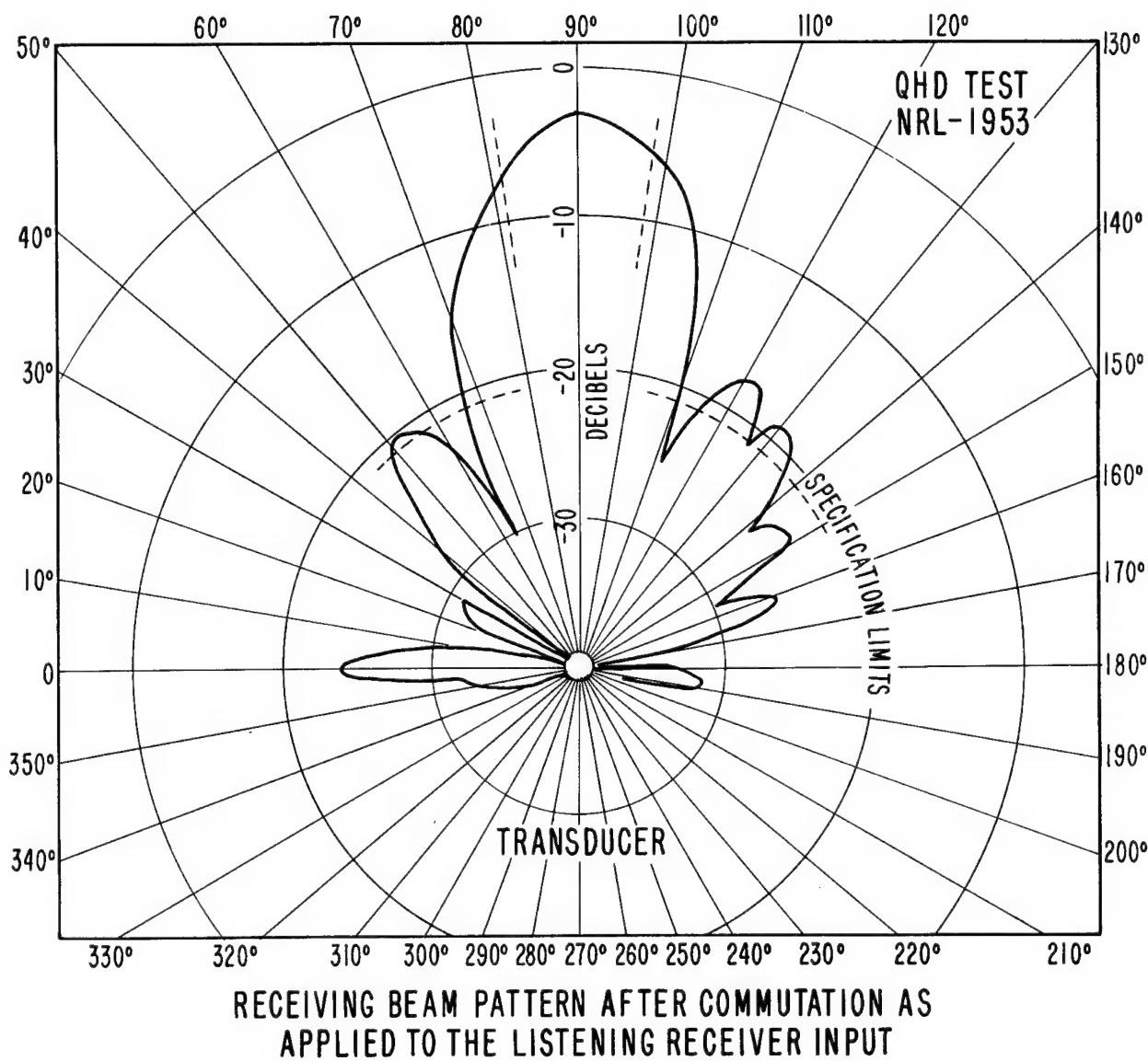


FIGURE 30

UNCLASSIFIED

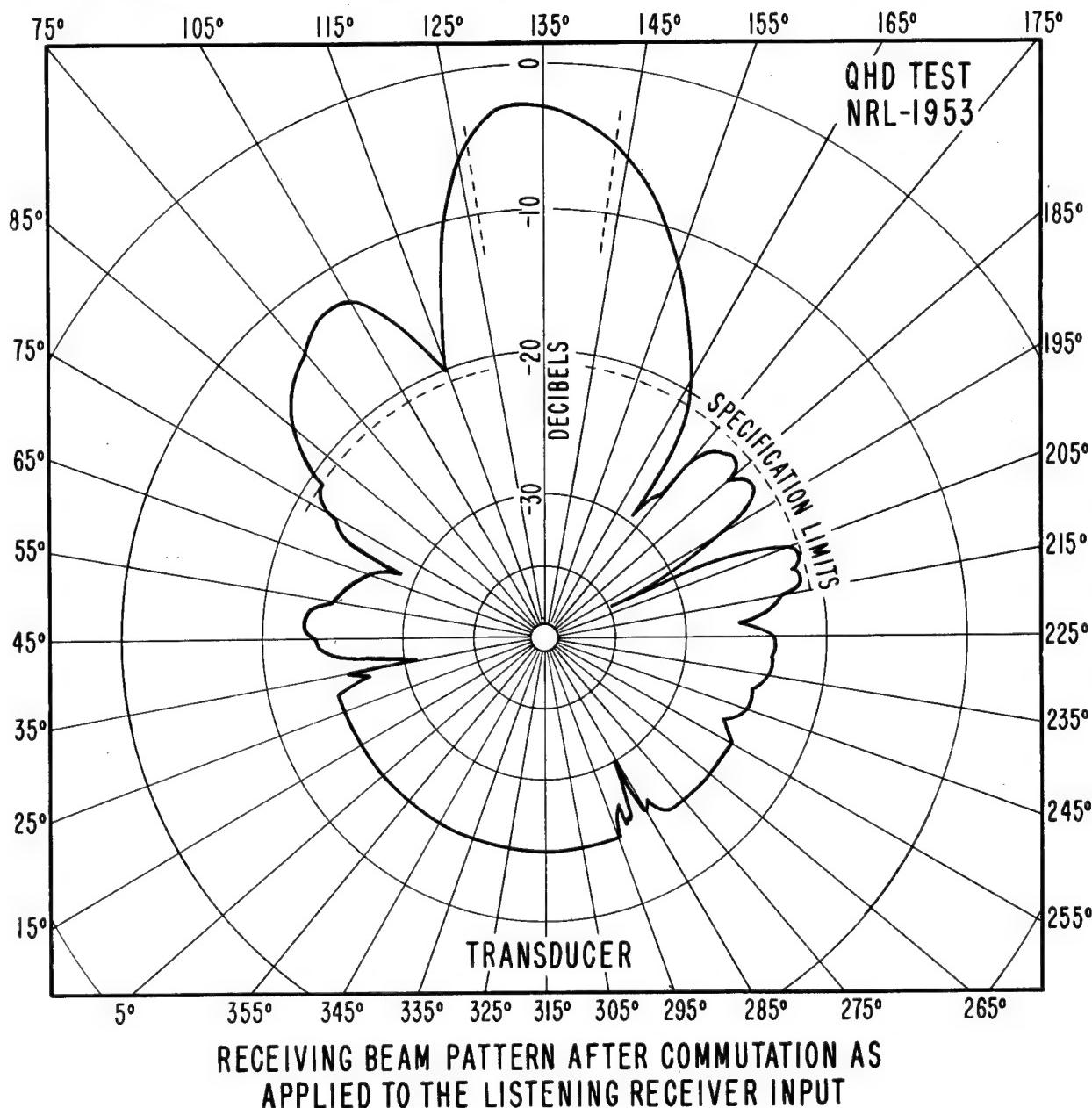


FIGURE 31

UNCLASSIFIED

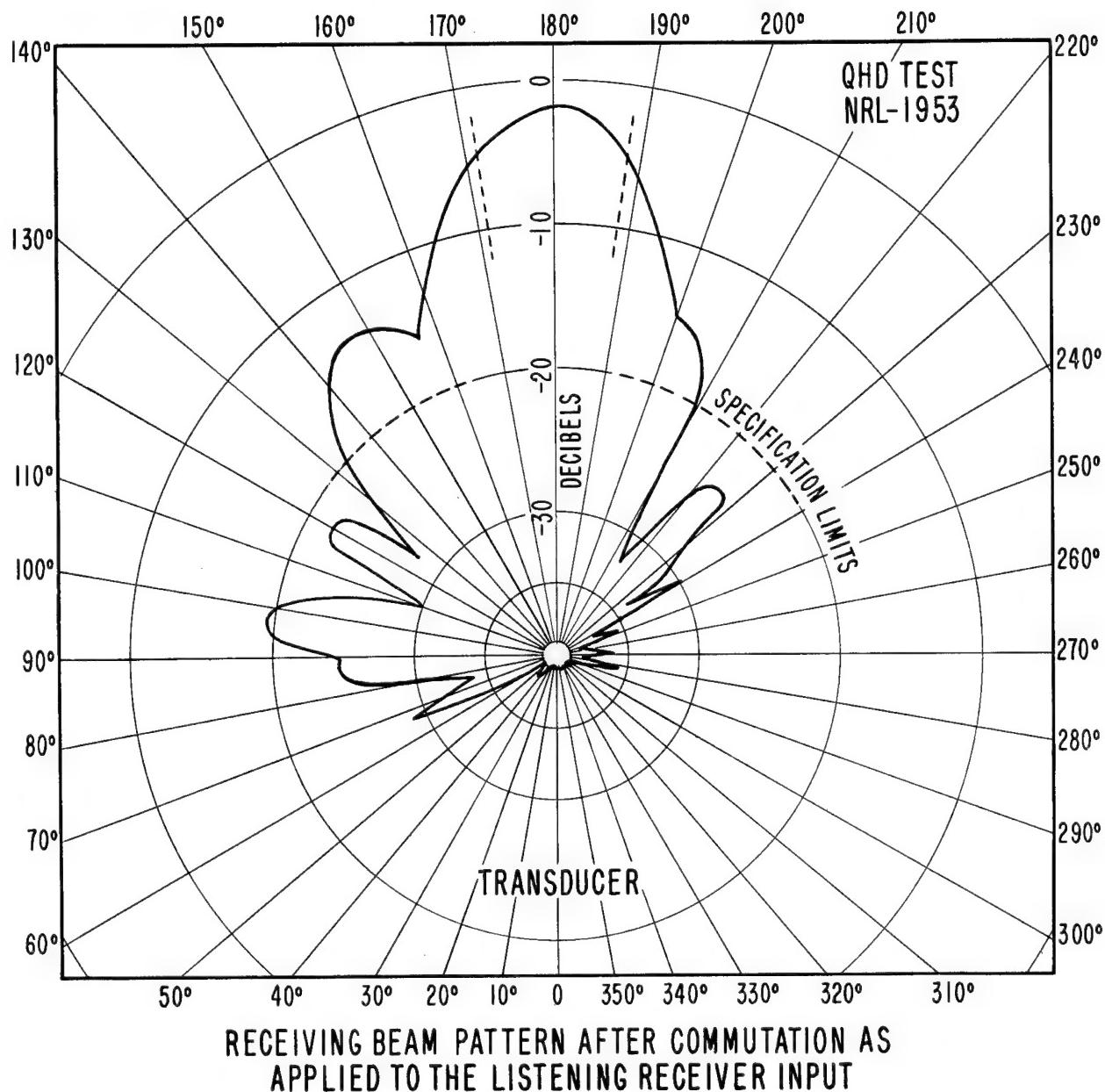


FIGURE 32

UNCLASSIFIED

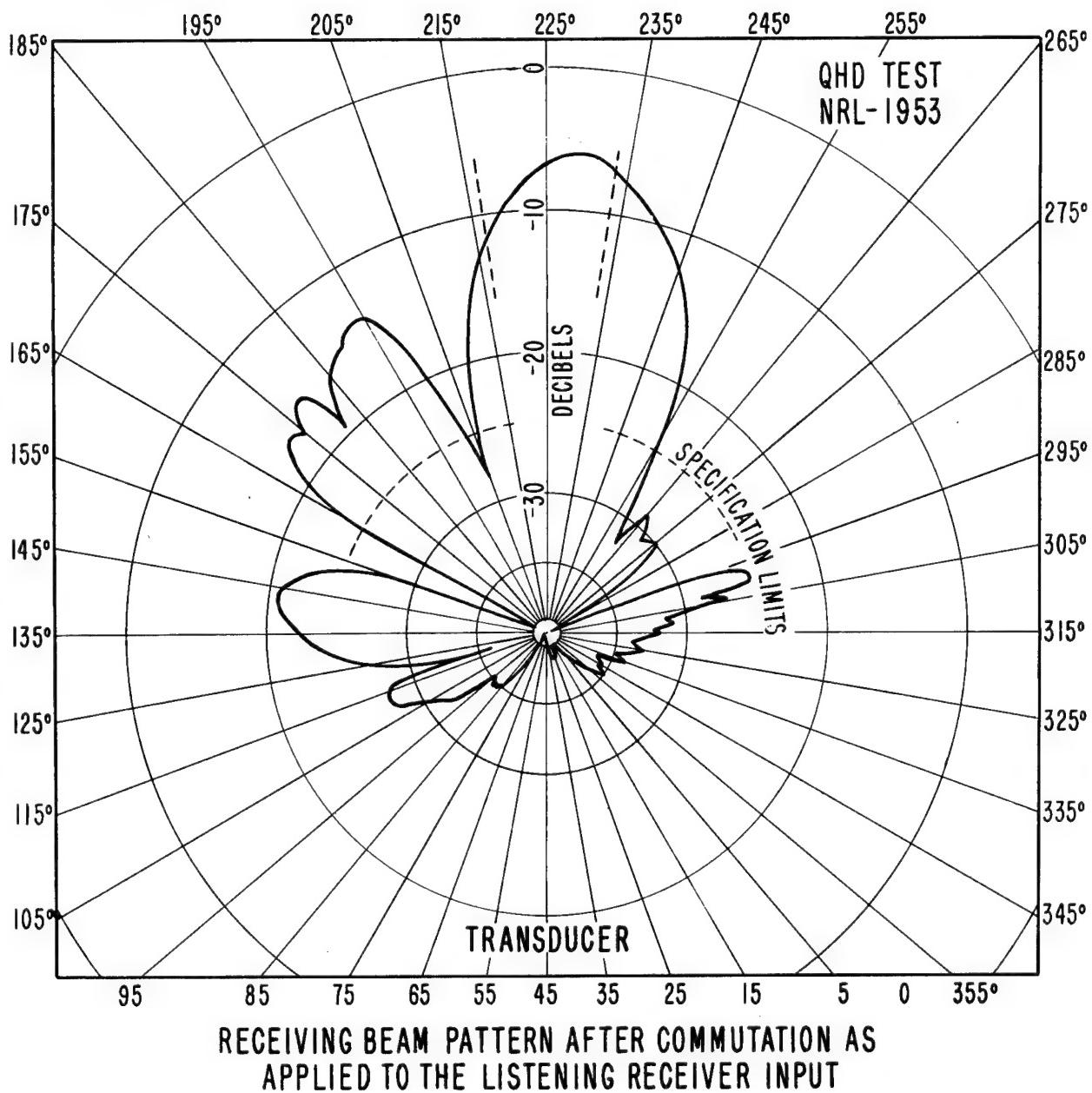


FIGURE 33

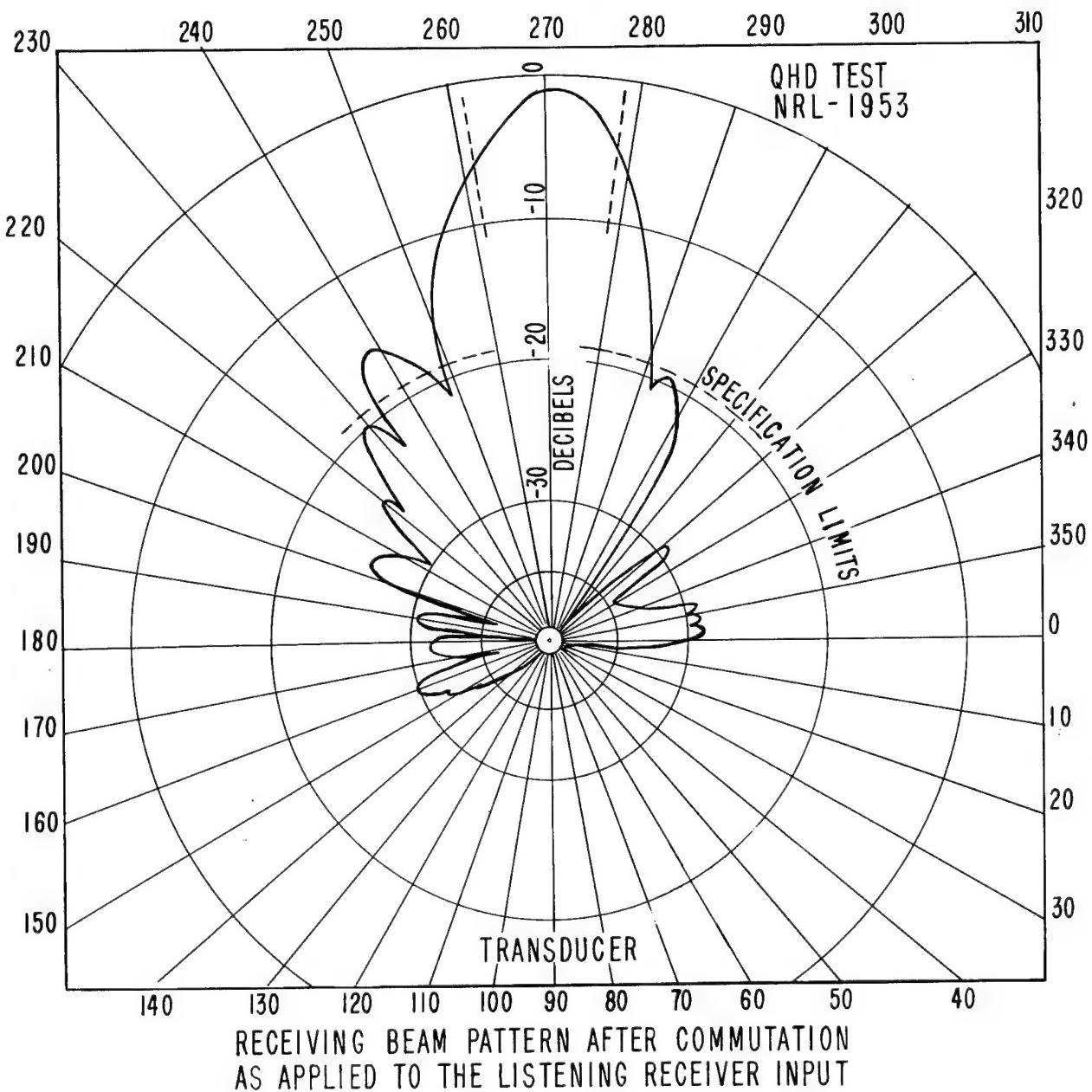


FIGURE 34

UNCLASSIFIED

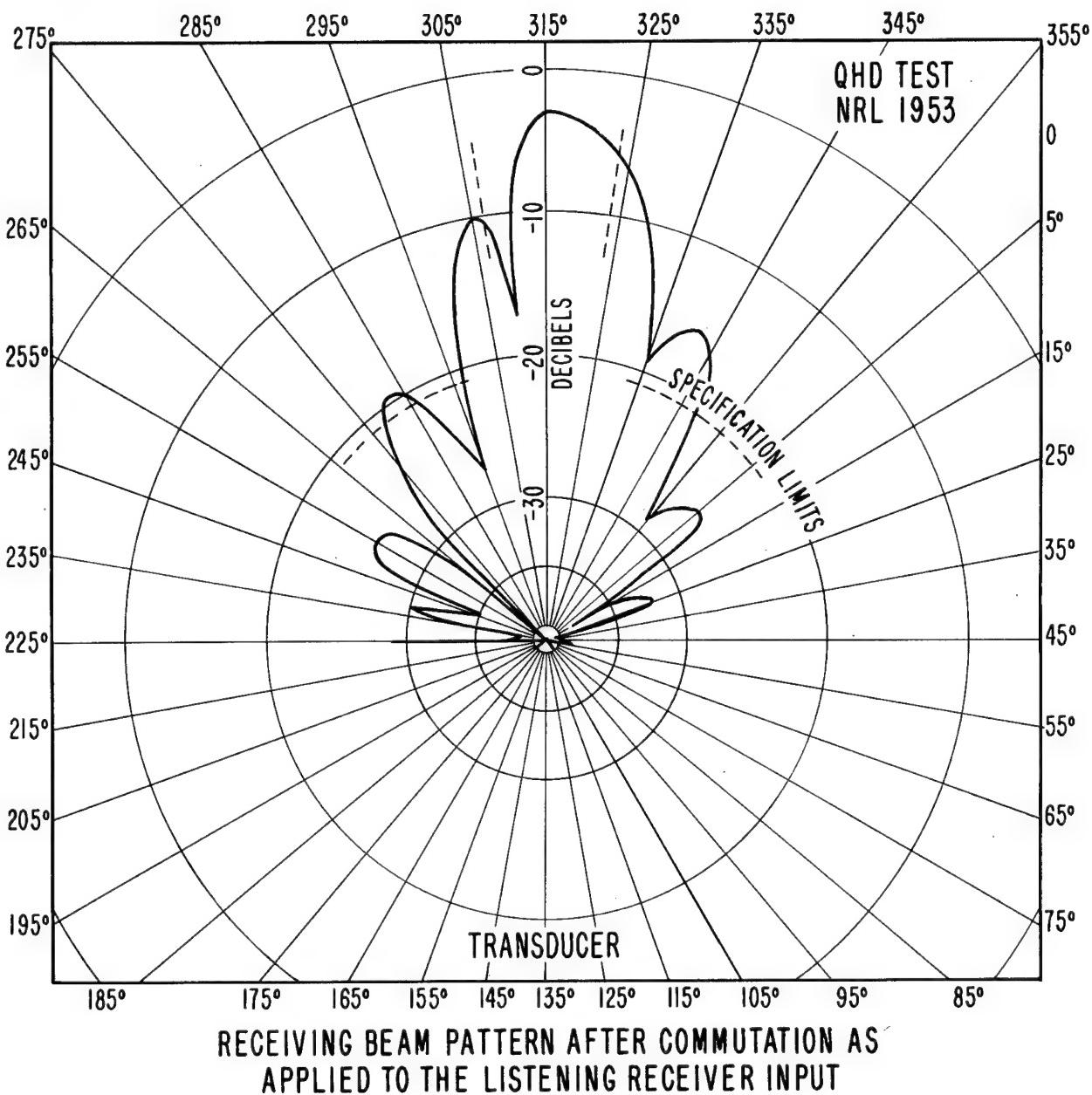
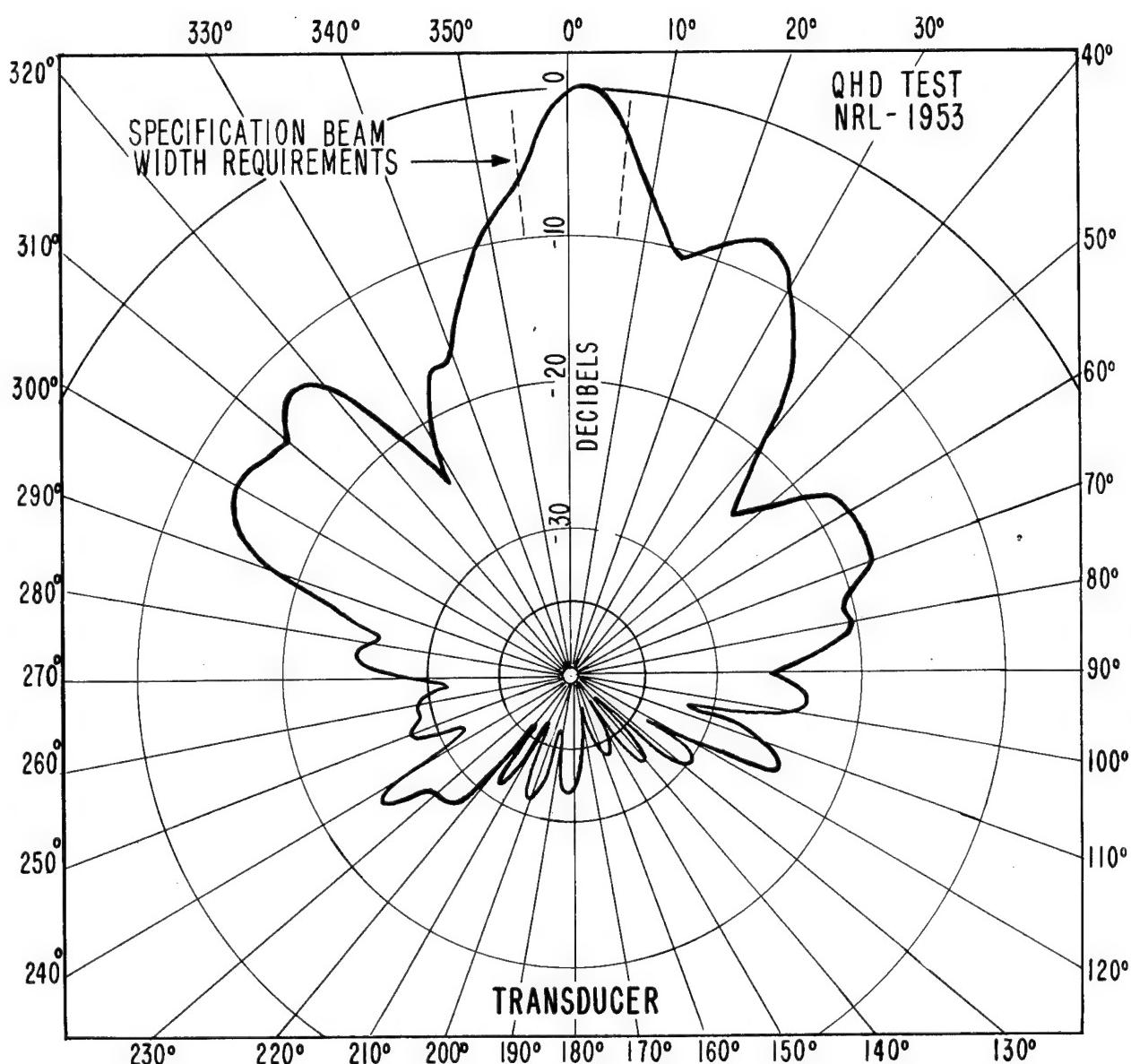


FIGURE 35



STAVE #1 TRANSDUCER AND LENS NETWORK RECEIVING
BEAM PATTERN WITHOUT COMMUTATION

UNCLASSIFIED

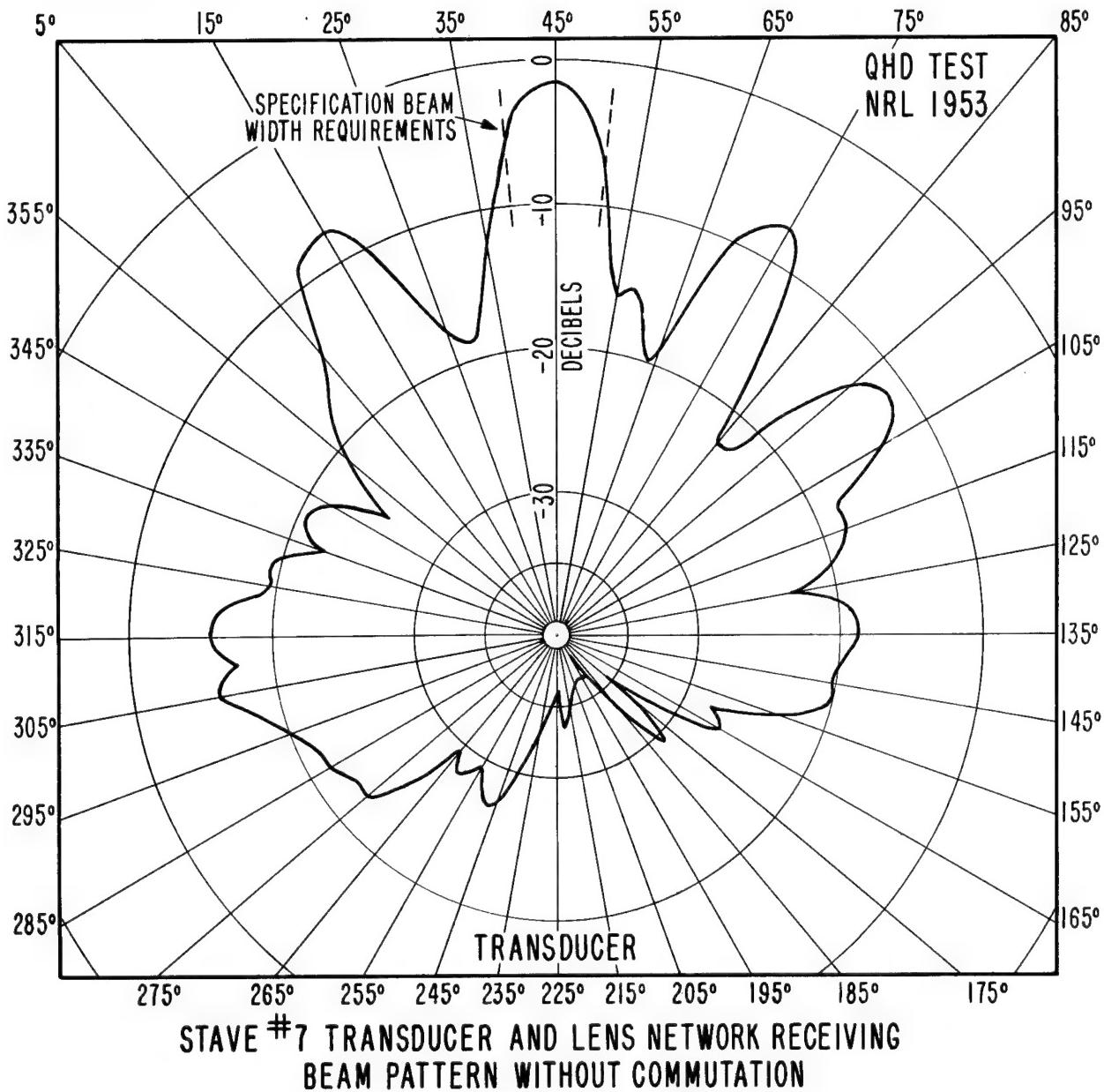
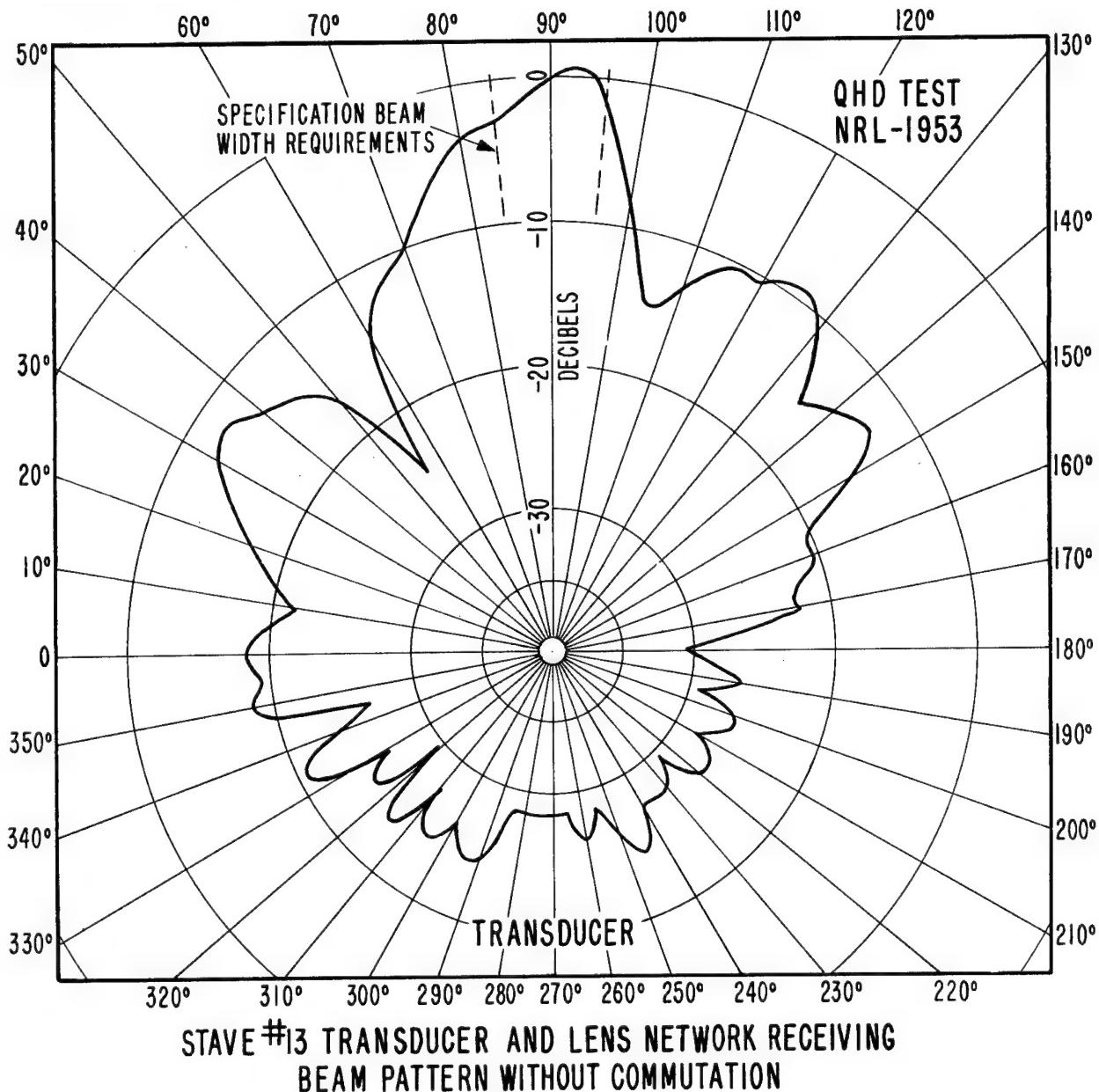


FIGURE 37

UNCLASSIFIED



STAVE #13 TRANSDUCER AND LENS NETWORK RECEIVING
BEAM PATTERN WITHOUT COMMUTATION

FIGURE 38

UNCLASSIFIED

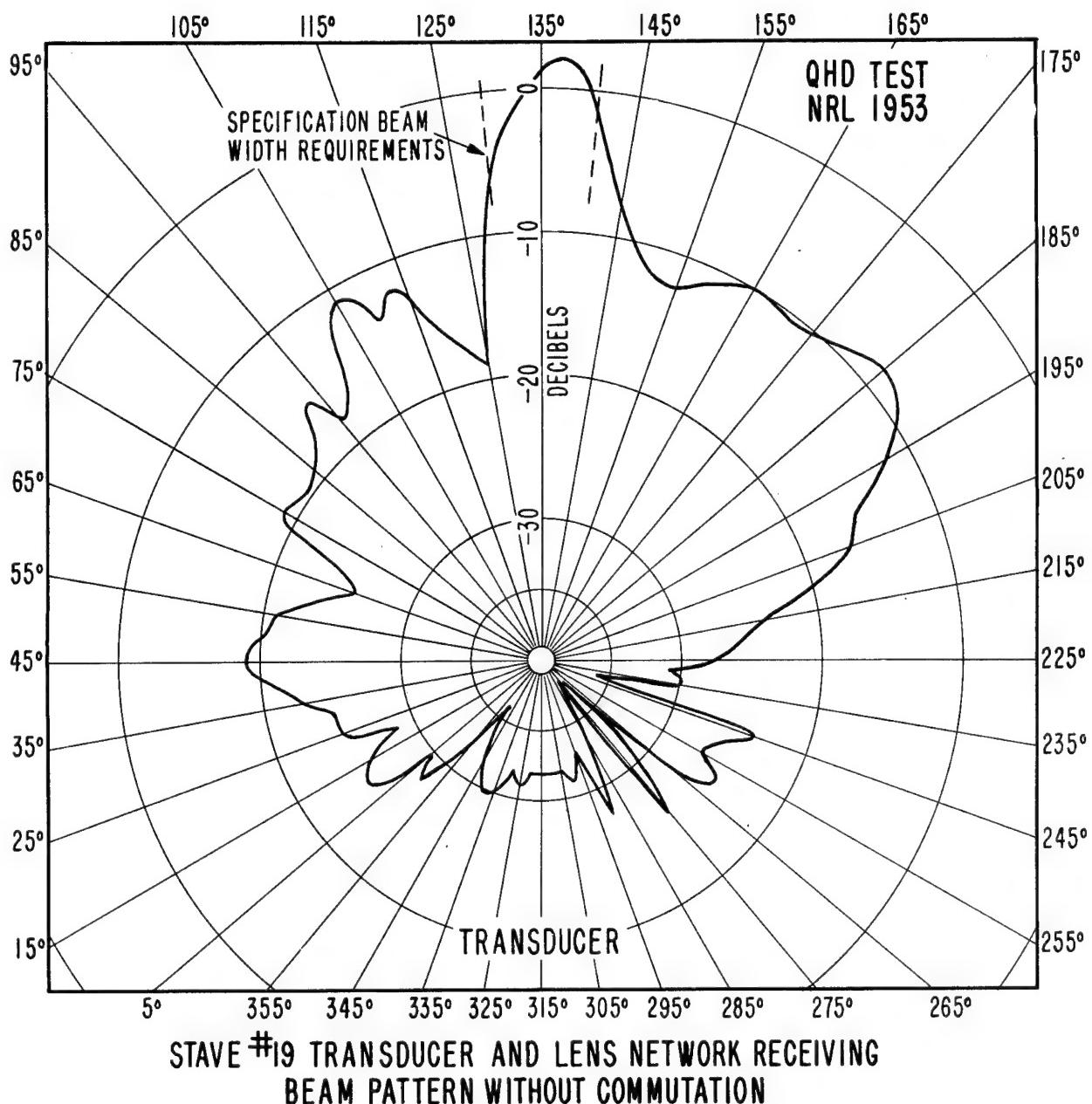


FIGURE 39

UNCLASSIFIED

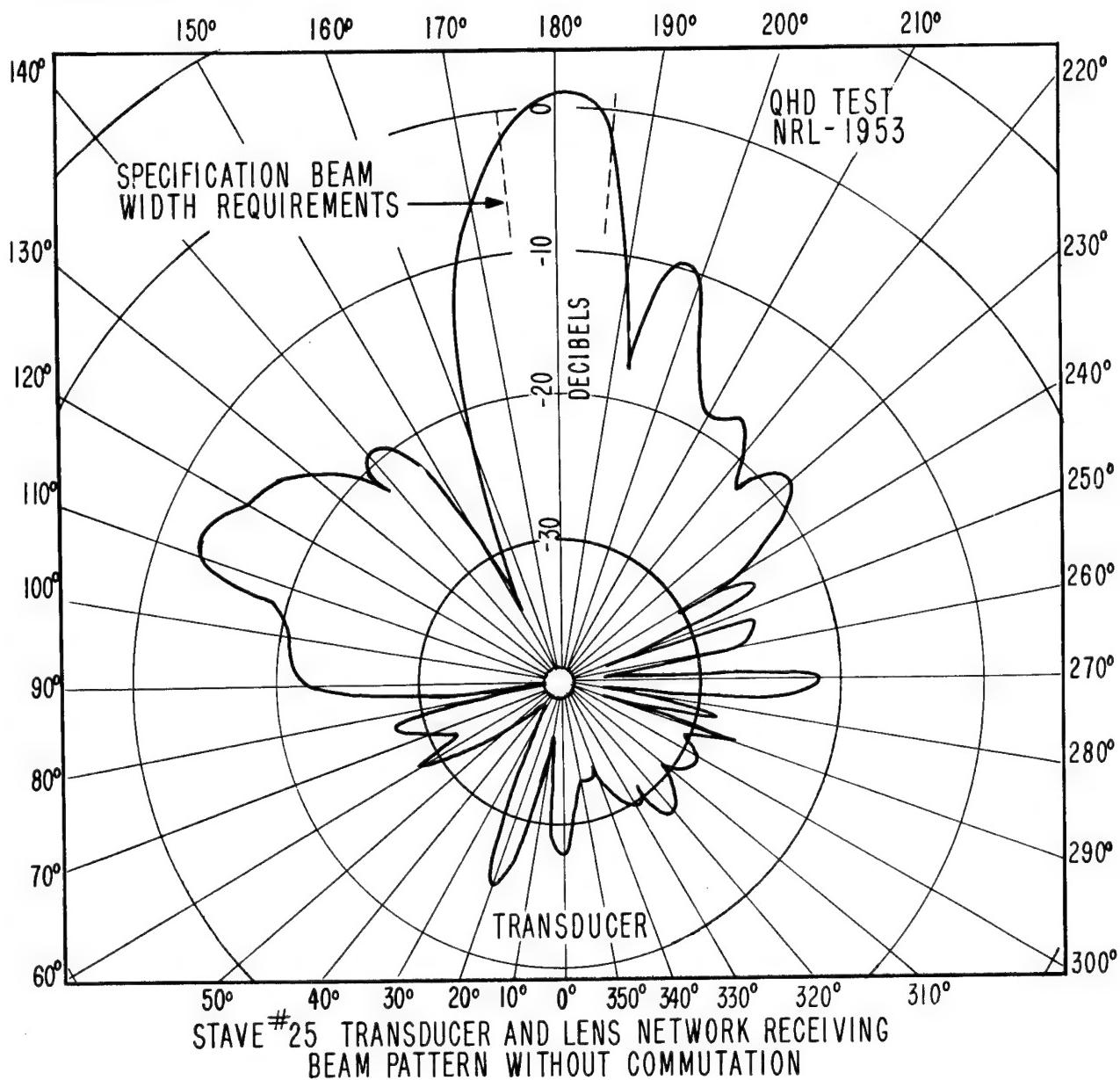


FIGURE 40

UNCLASSIFIED

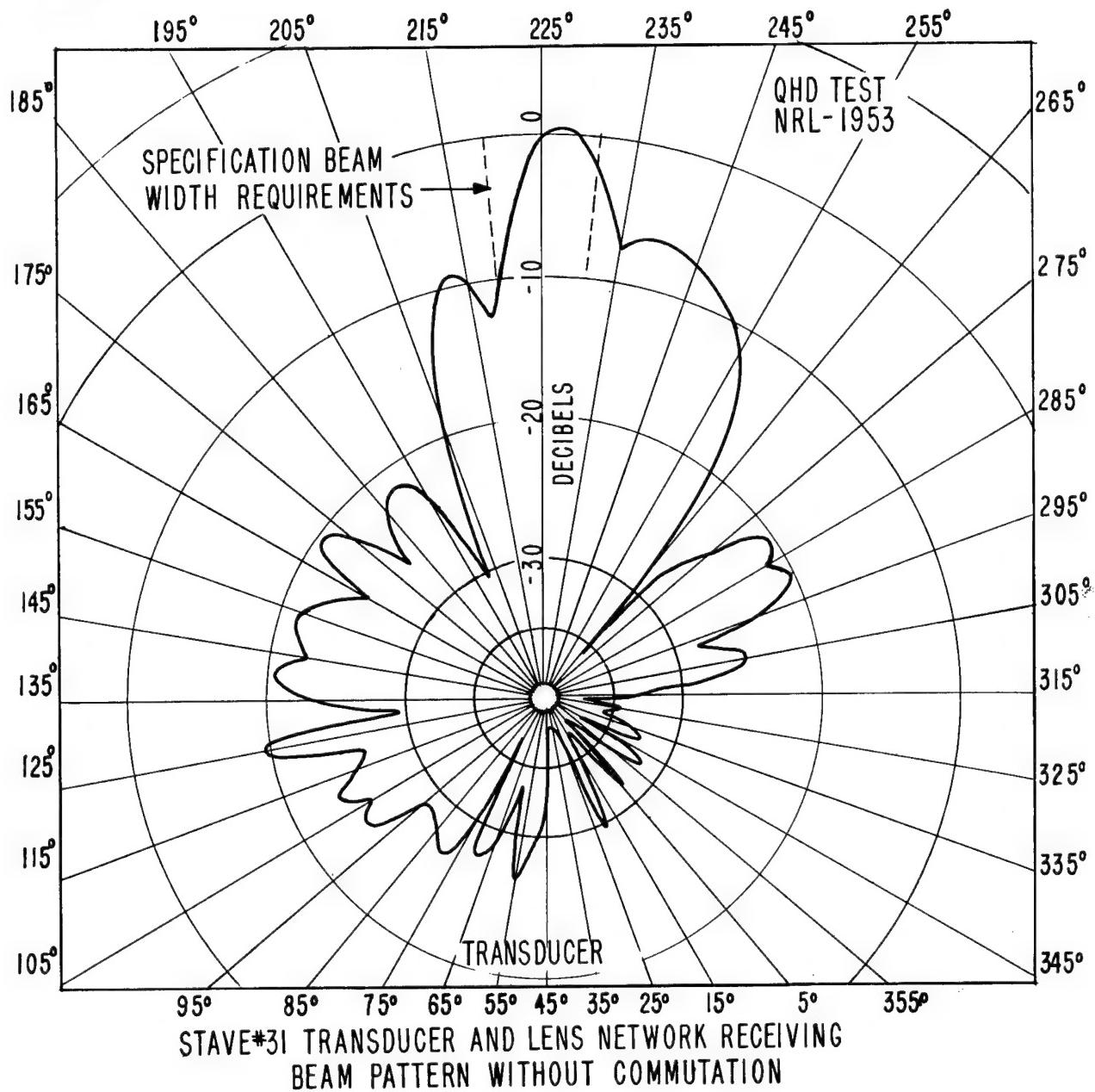
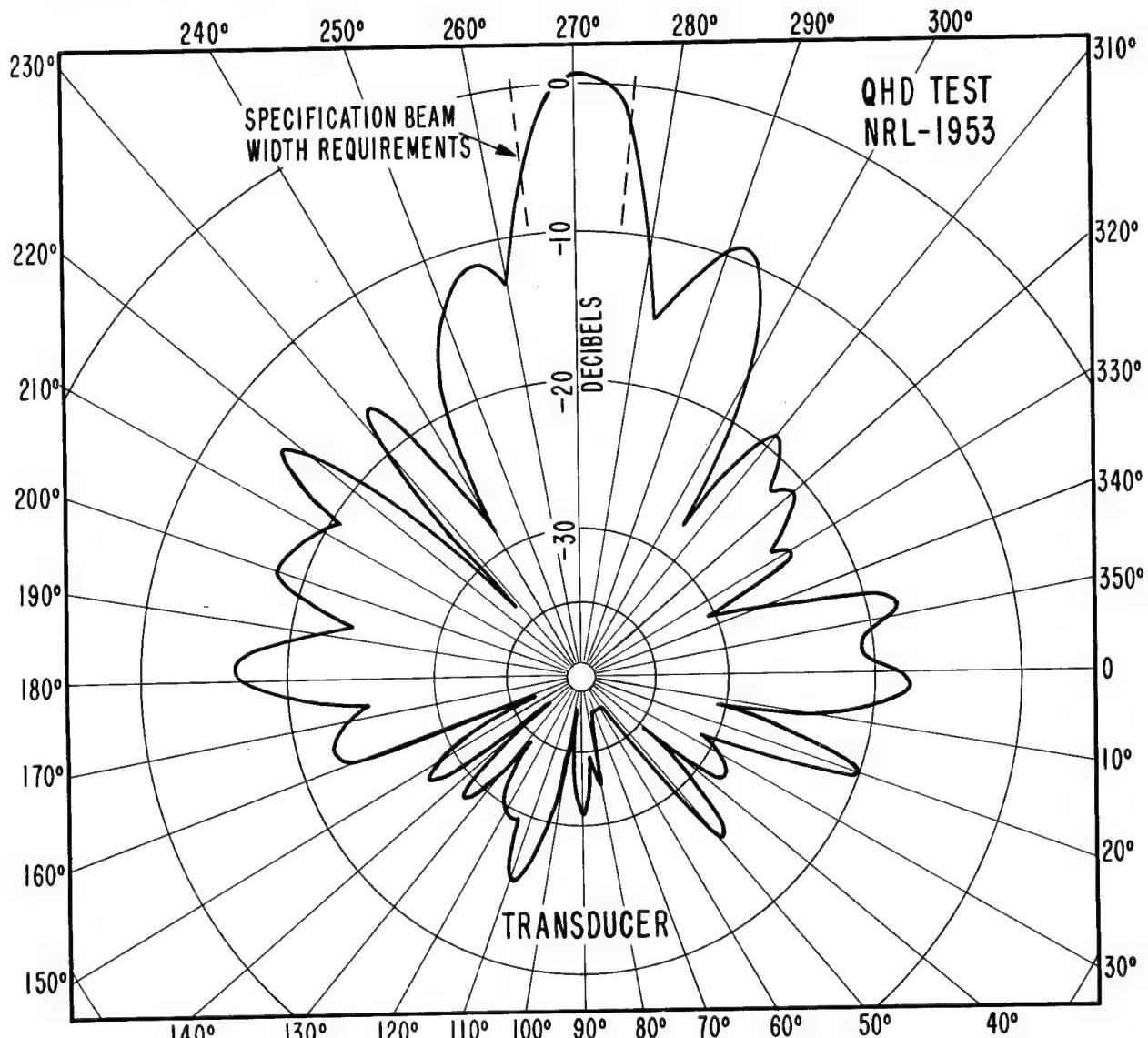


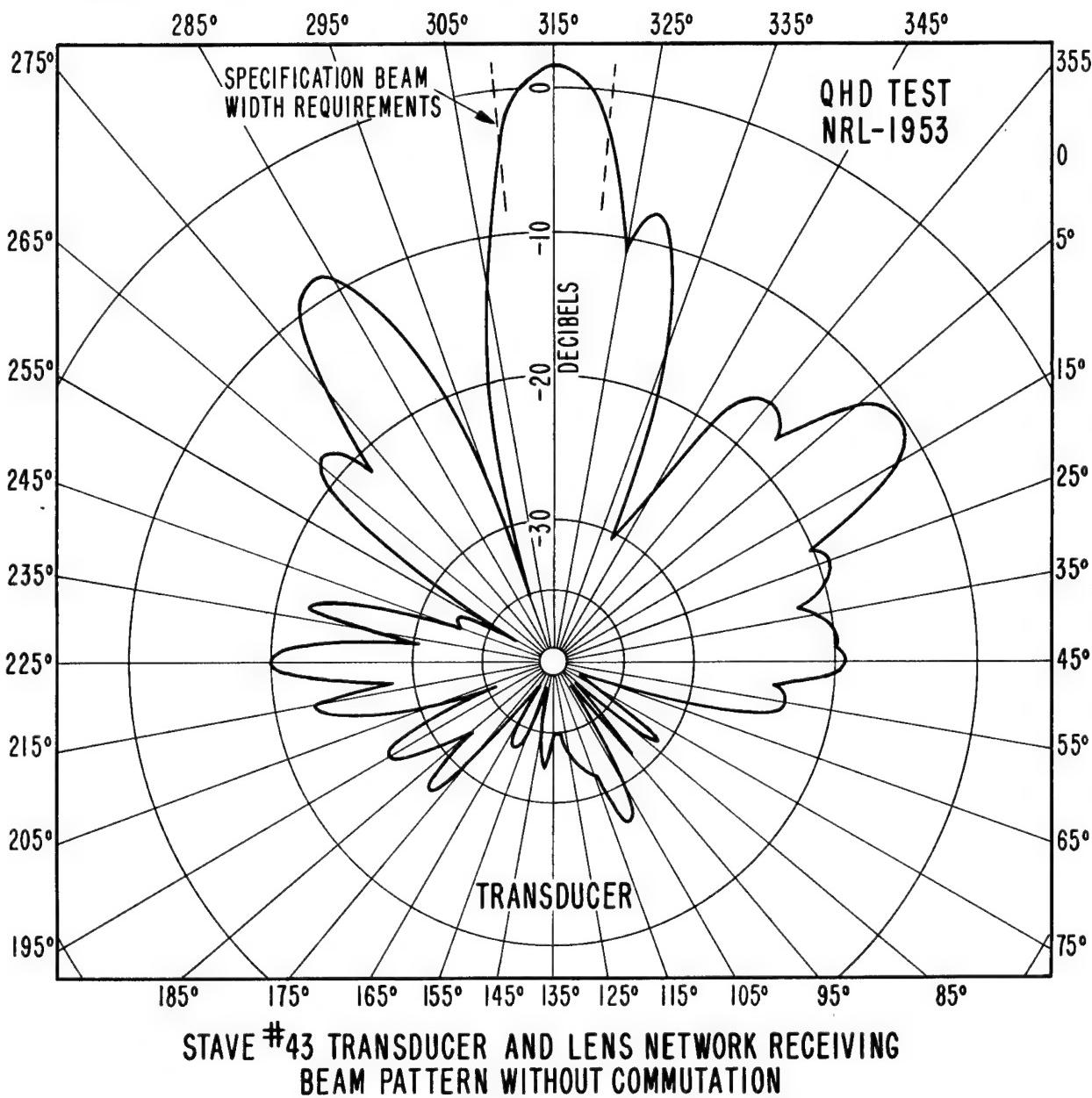
FIGURE 41

UNCLASSIFIED



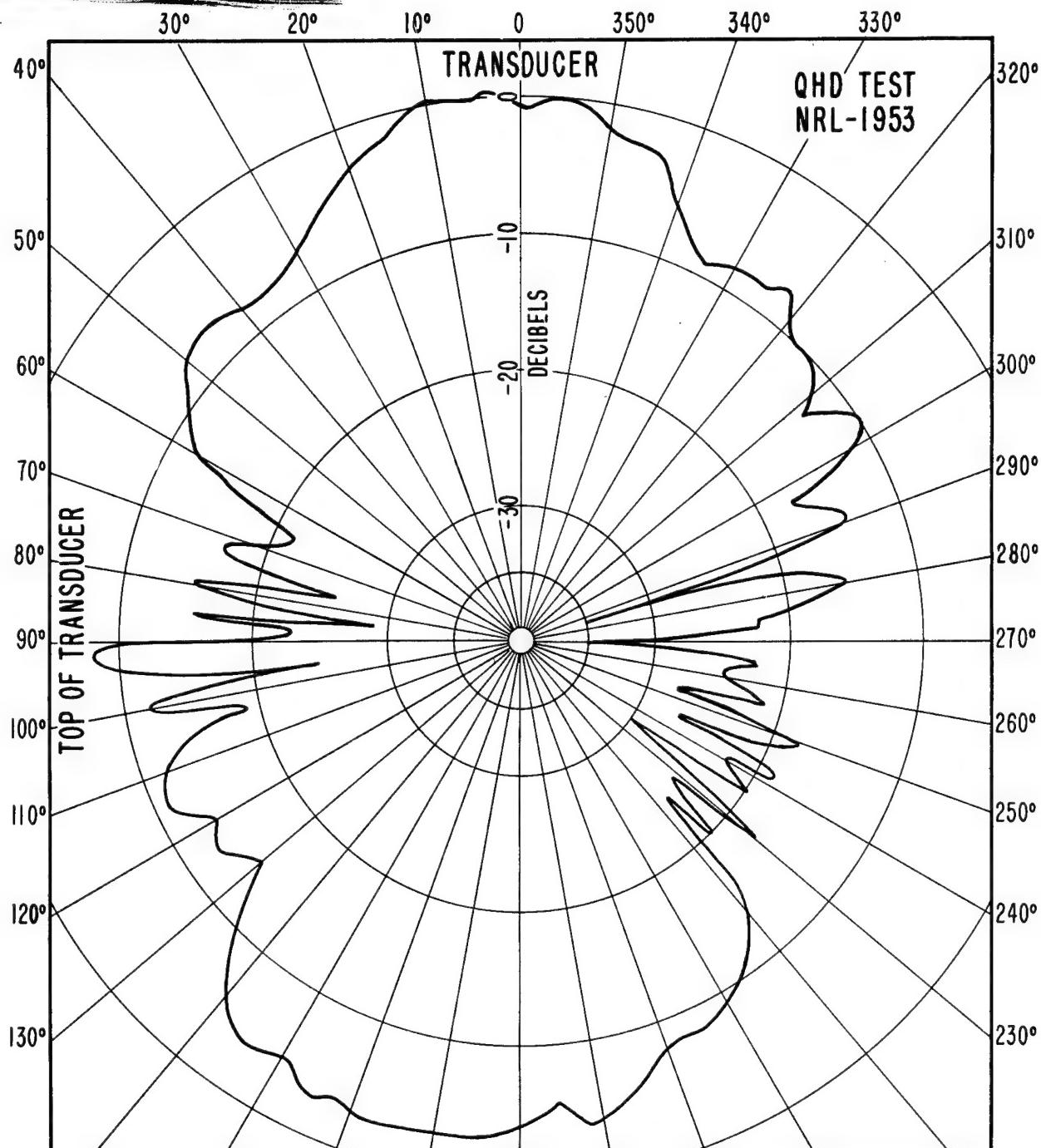
STAVE #37 TRANSDUCER AND LENS NETWORK RECEIVING
BEAM PATTERN WITHOUT COMMUTATION

FIGURE 42



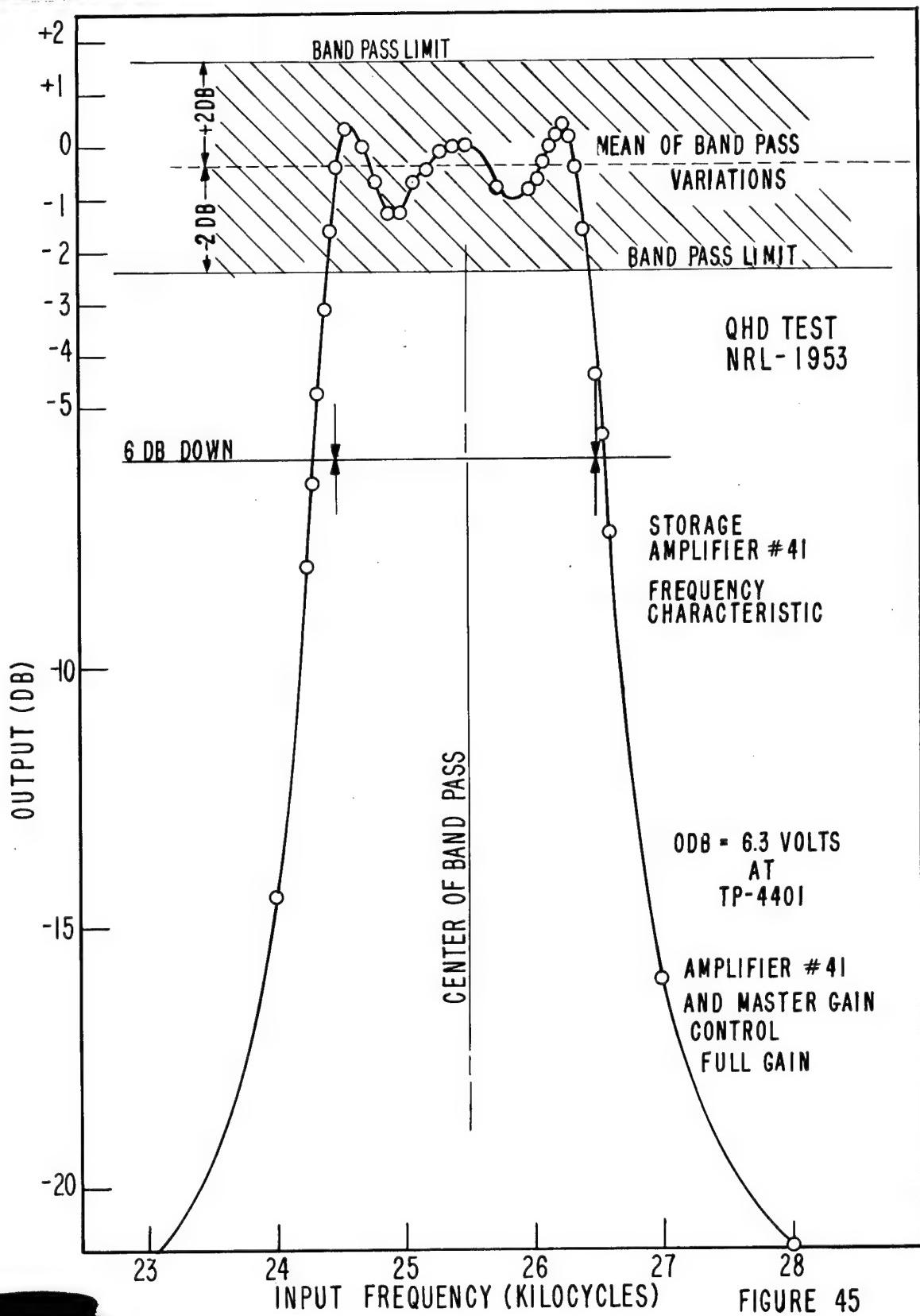
STAVE #43 TRANSDUCER AND LENS NETWORK RECEIVING
BEAM PATTERN WITHOUT COMMUTATION

UNCLASSIFIED



SOUND RADIATION PATTERN OF MCC SECTION VERTICAL PLANE
FOR SOUND LEVEL IN MICROBARS SEE PLATE NO. 23

FIGURE 44



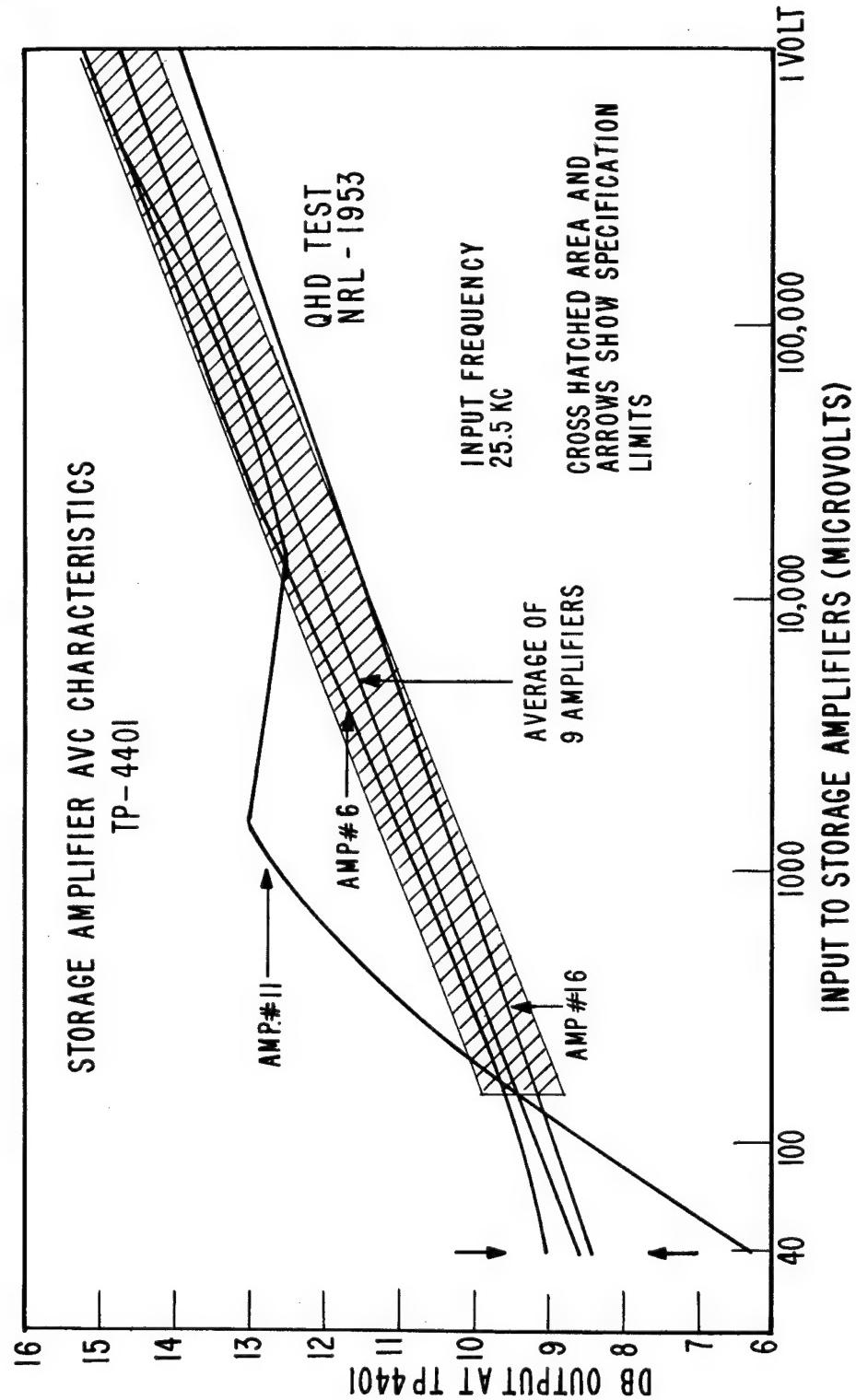


FIGURE 46

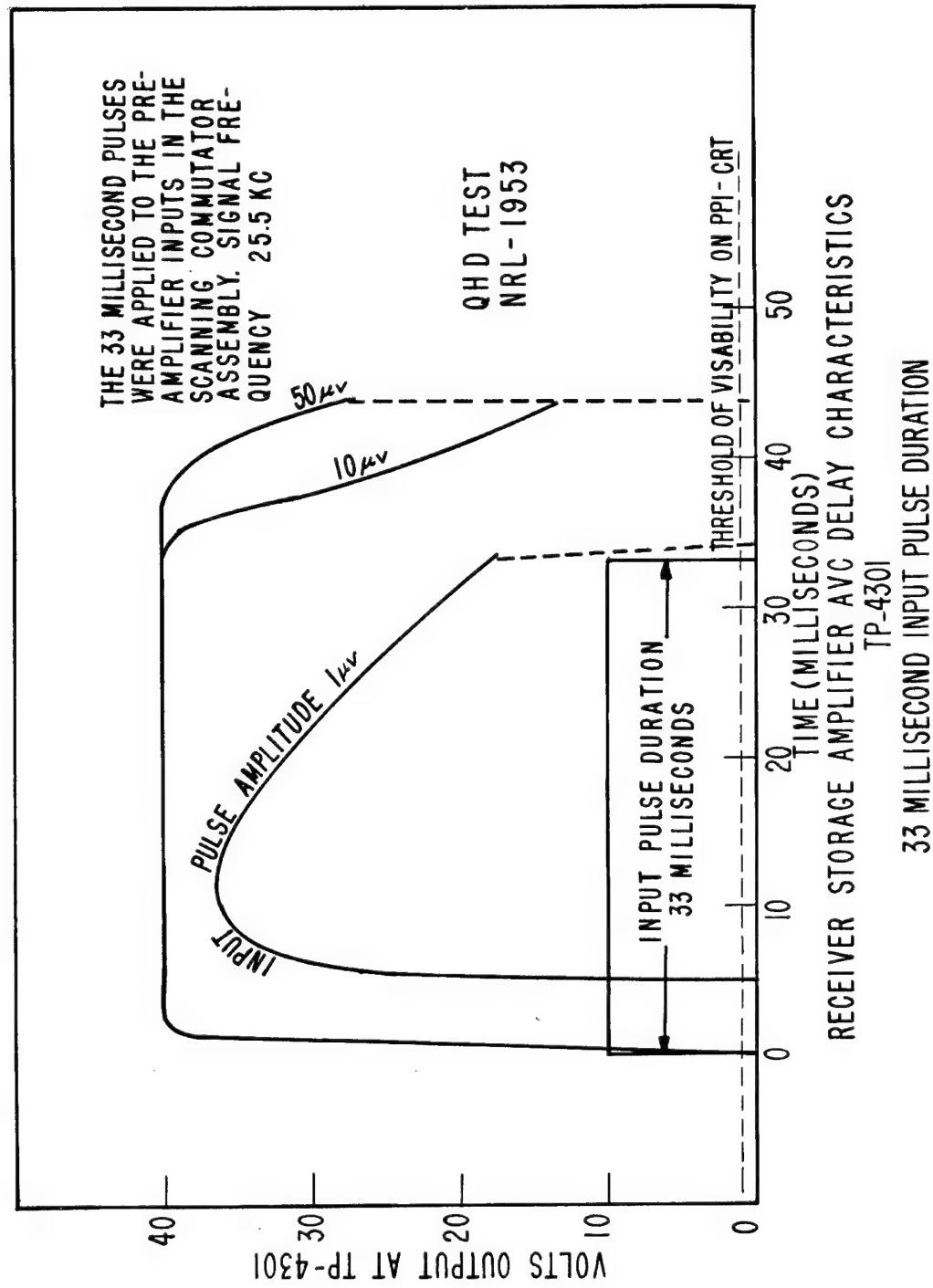


FIGURE 47

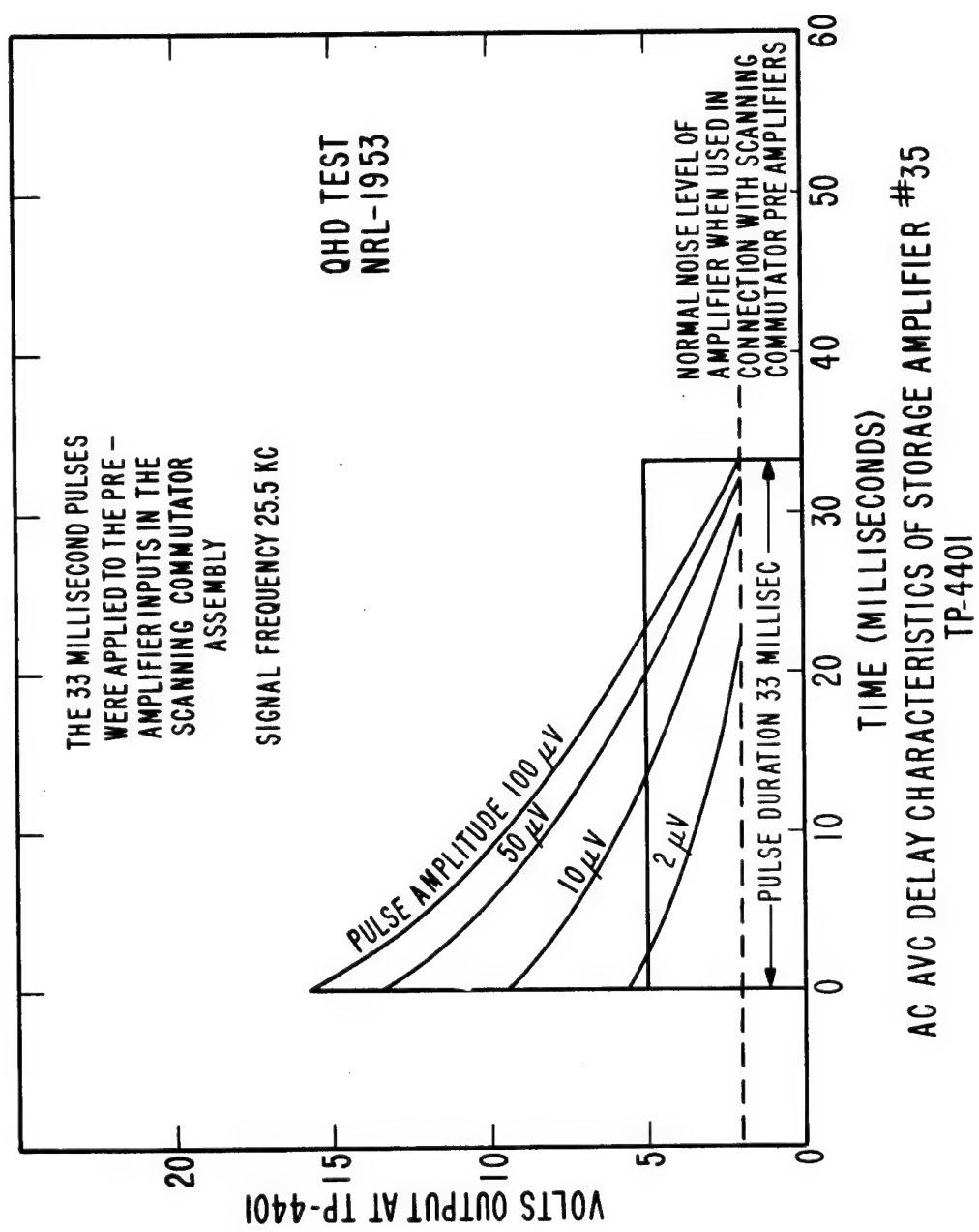


FIGURE 48

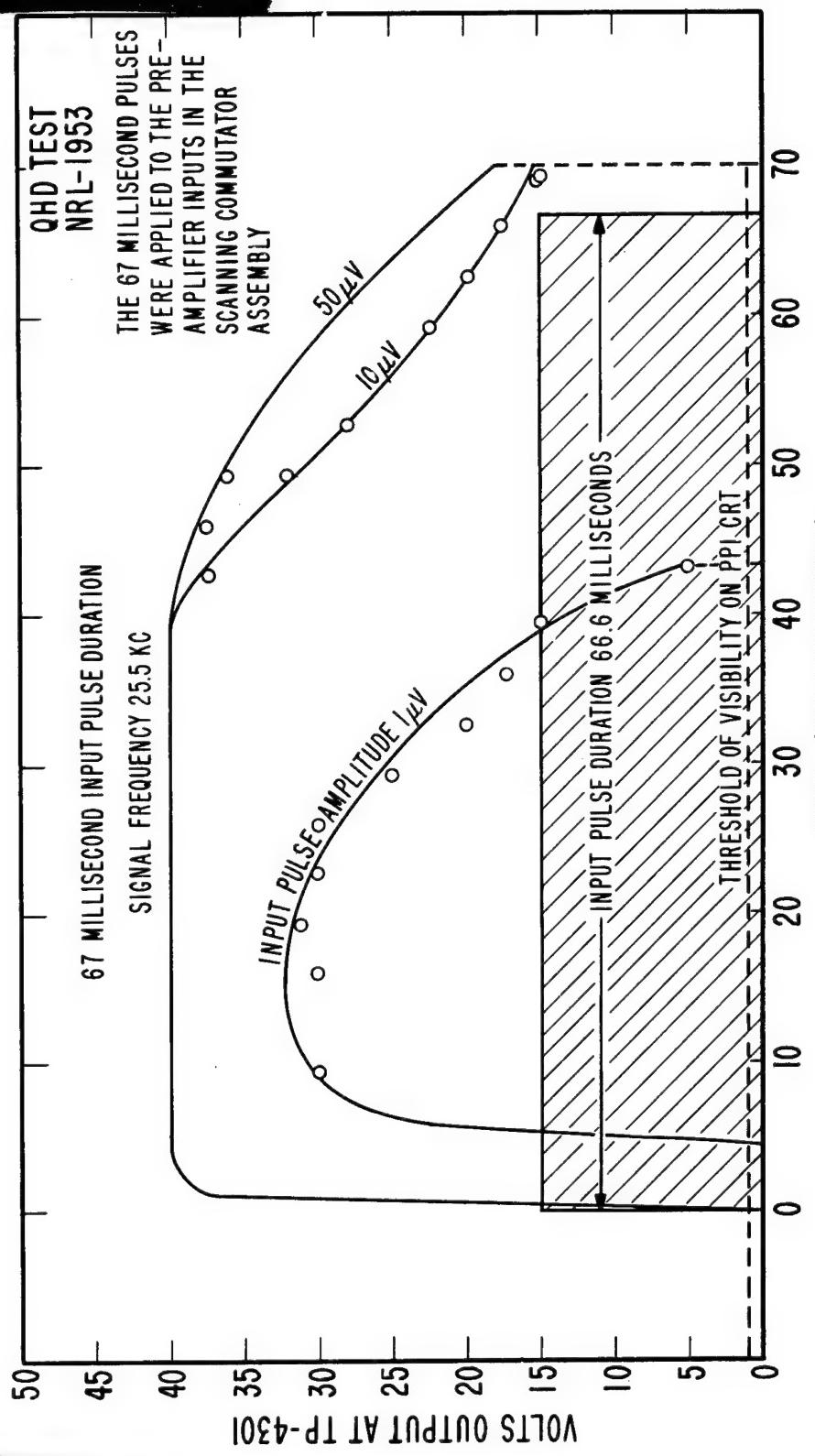


FIGURE 49

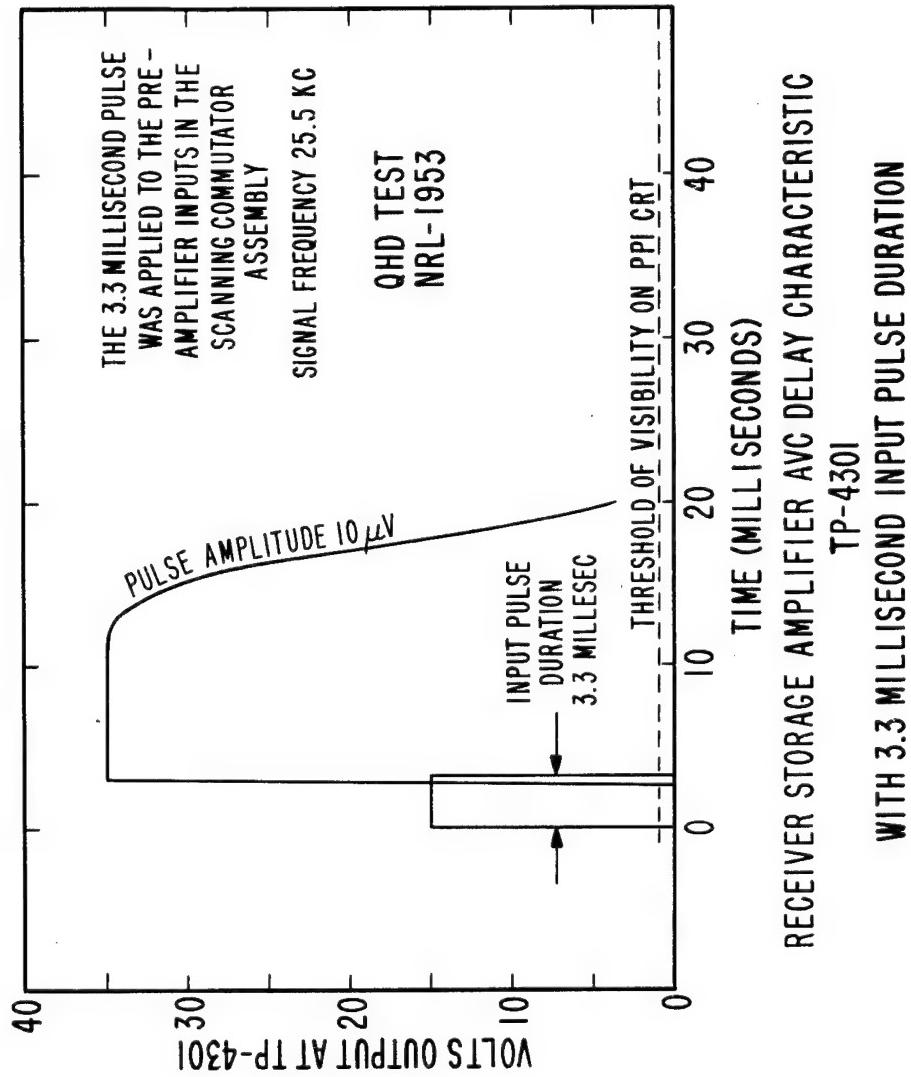


FIGURE 50

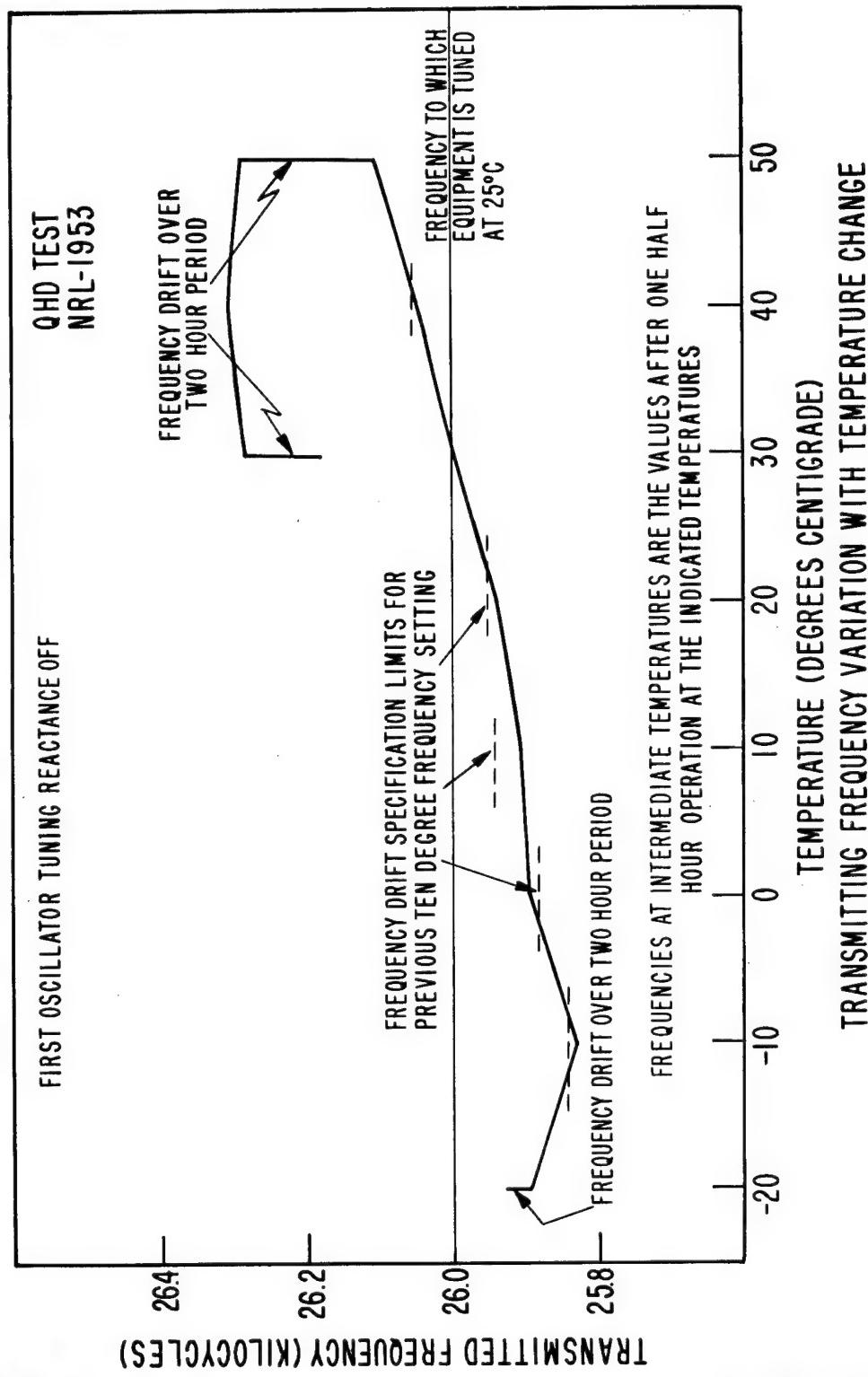


FIGURE 51

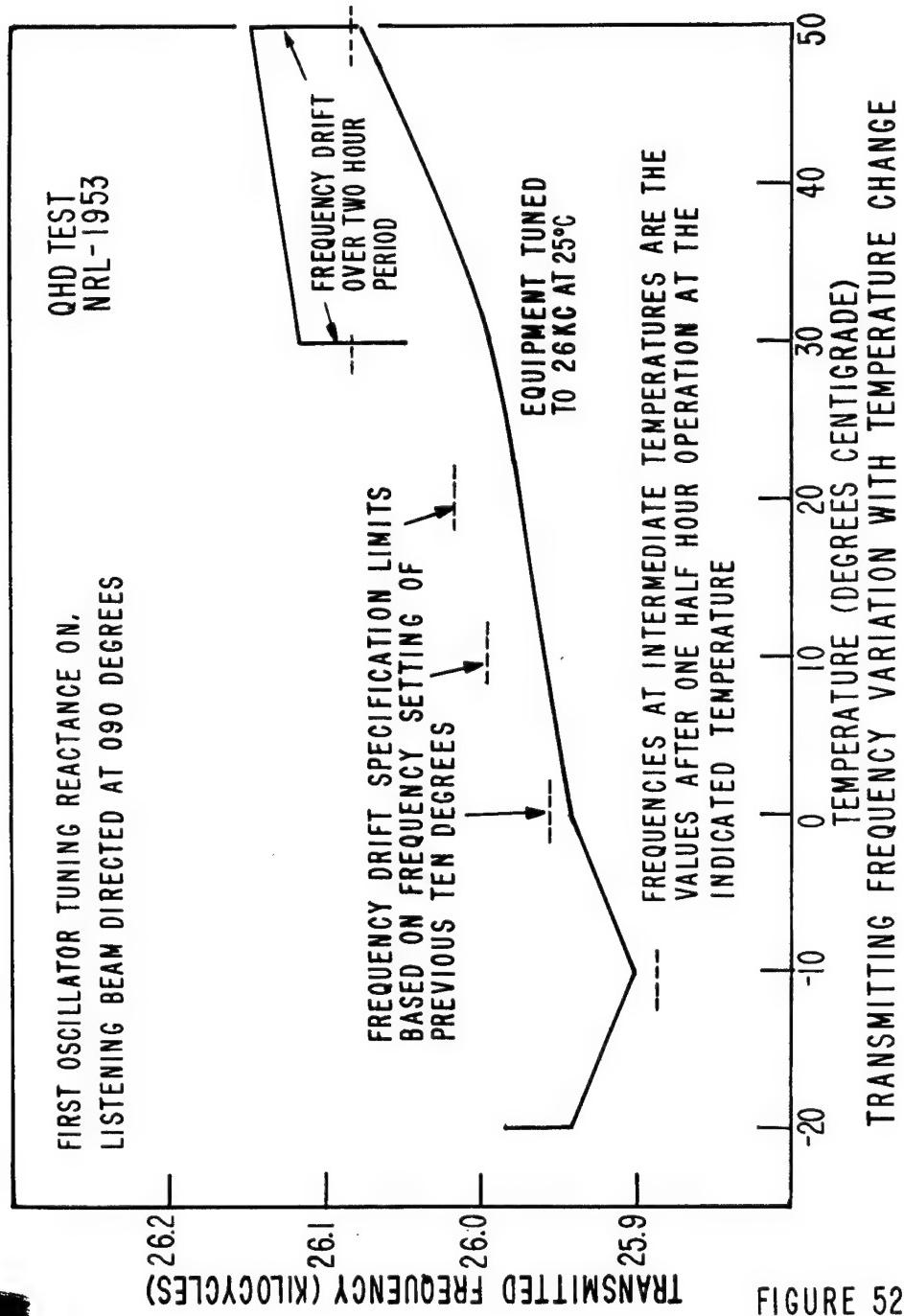


FIGURE 52

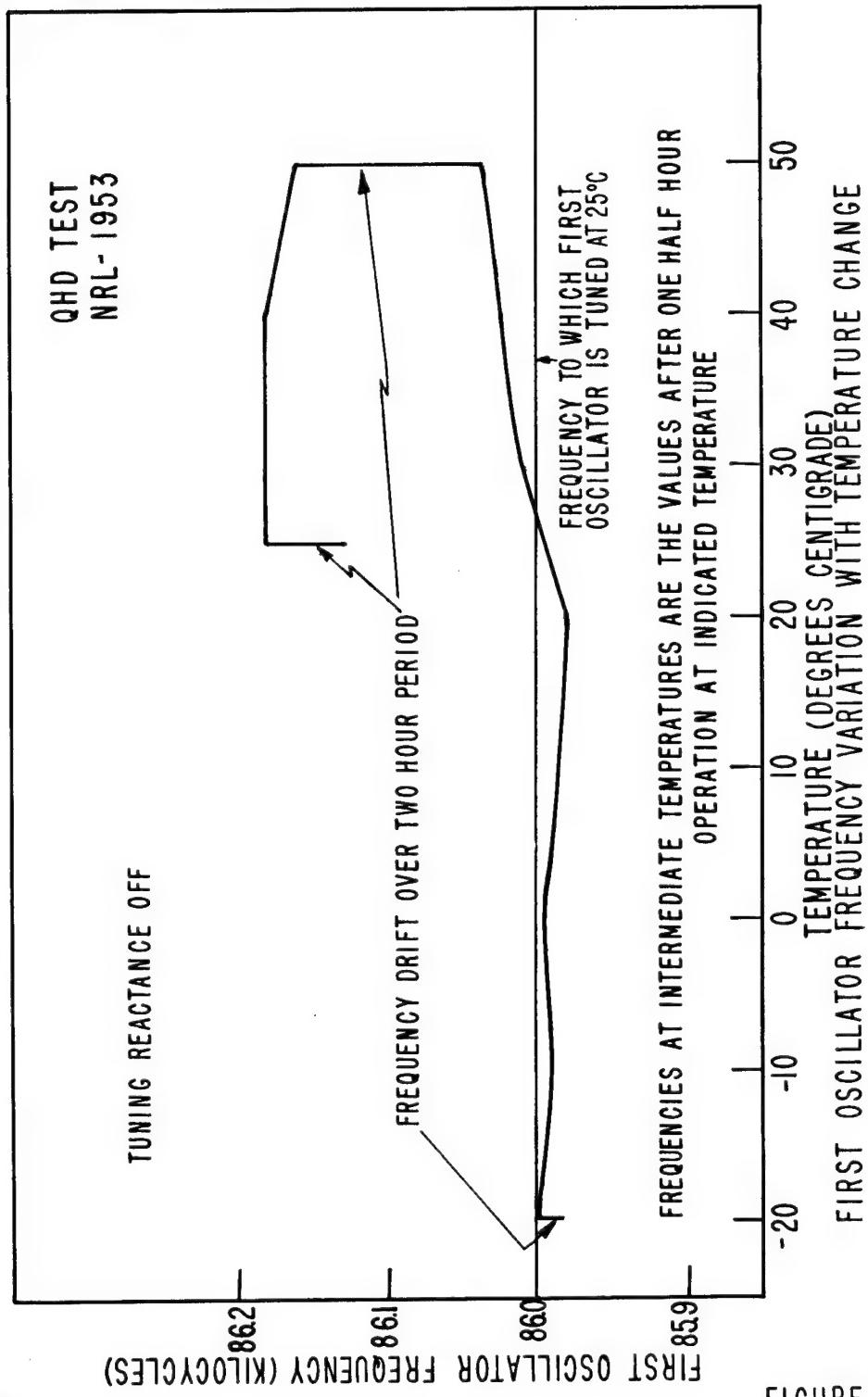


FIGURE 53

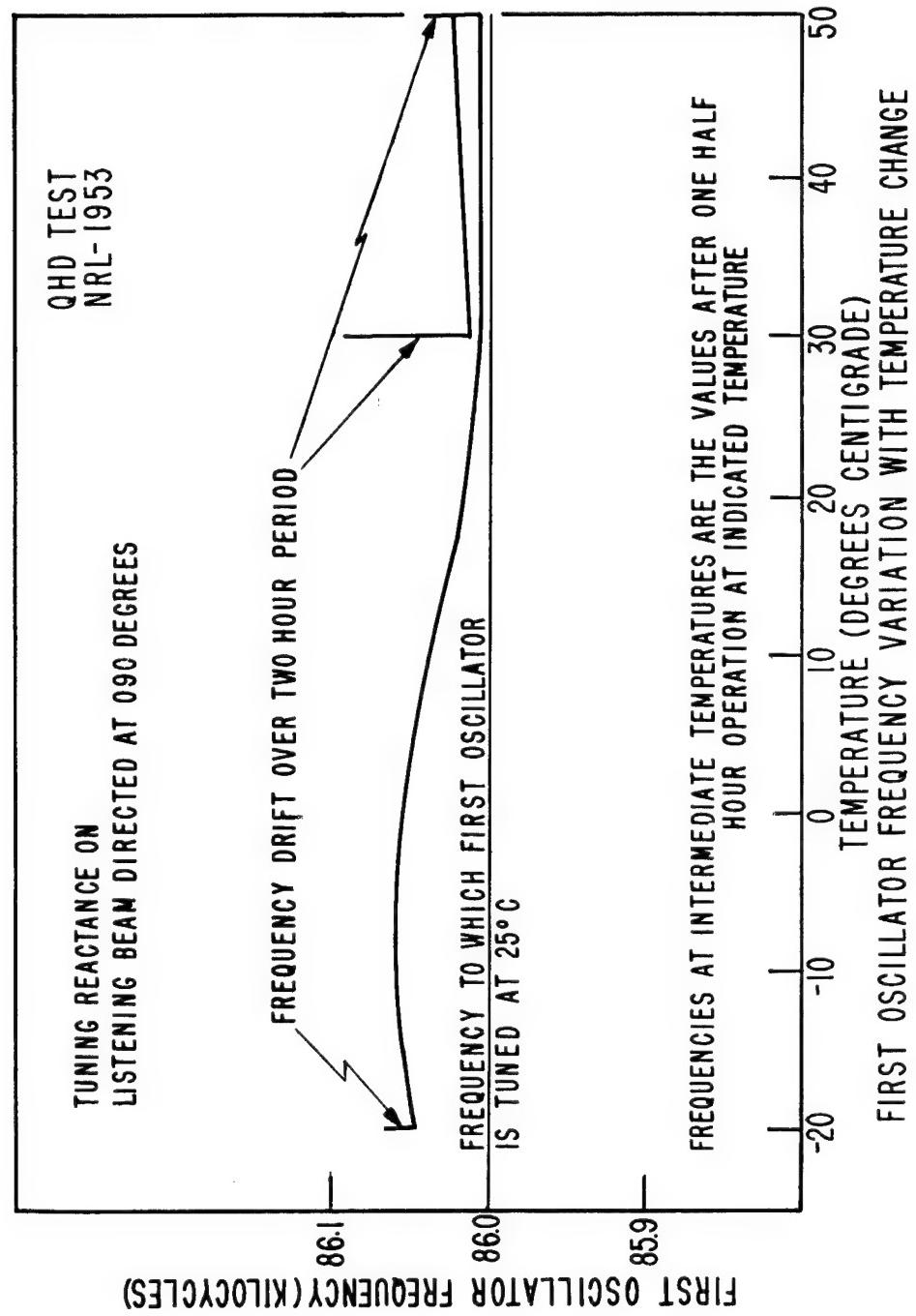


FIGURE 54

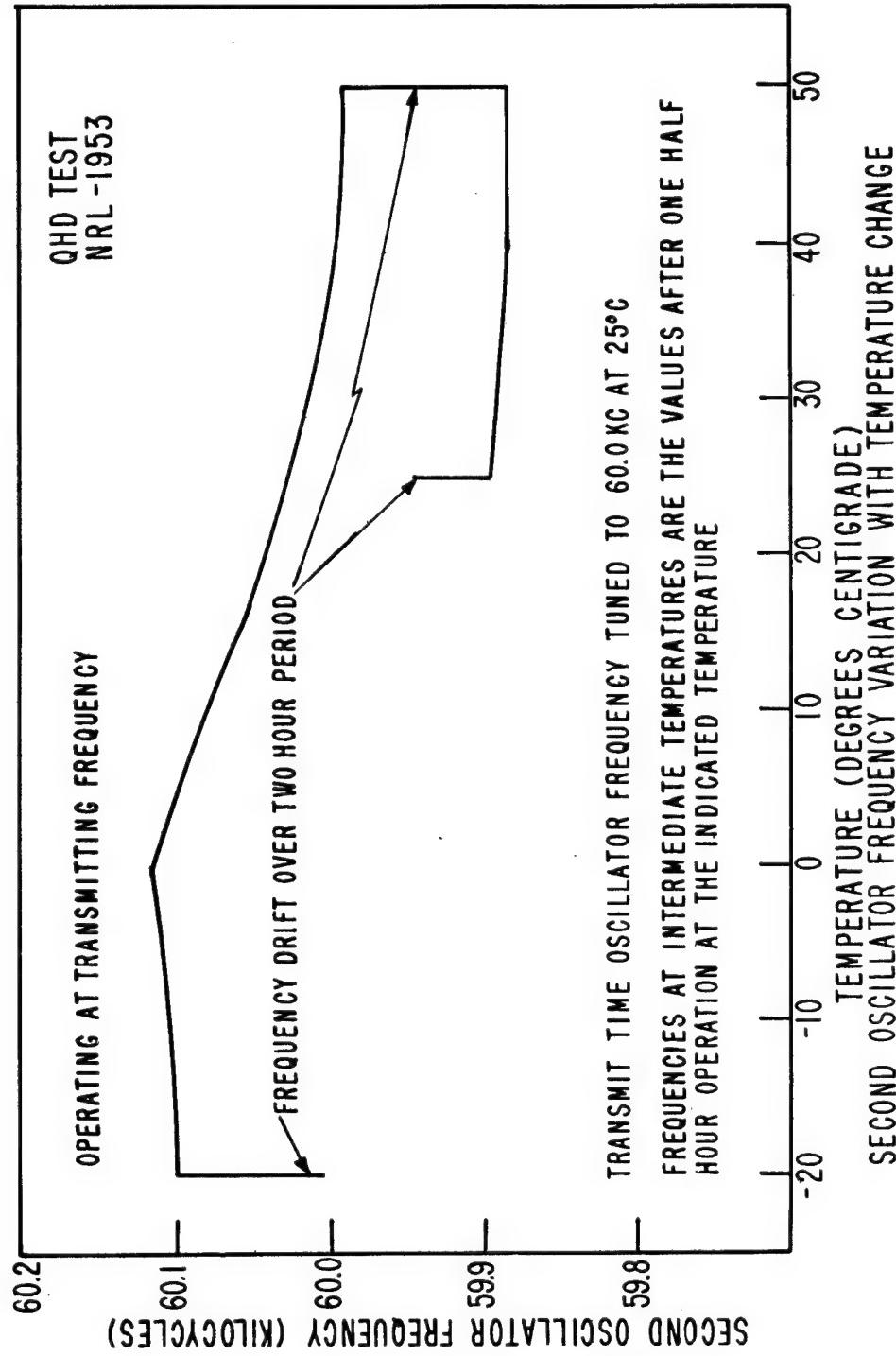


FIGURE 55

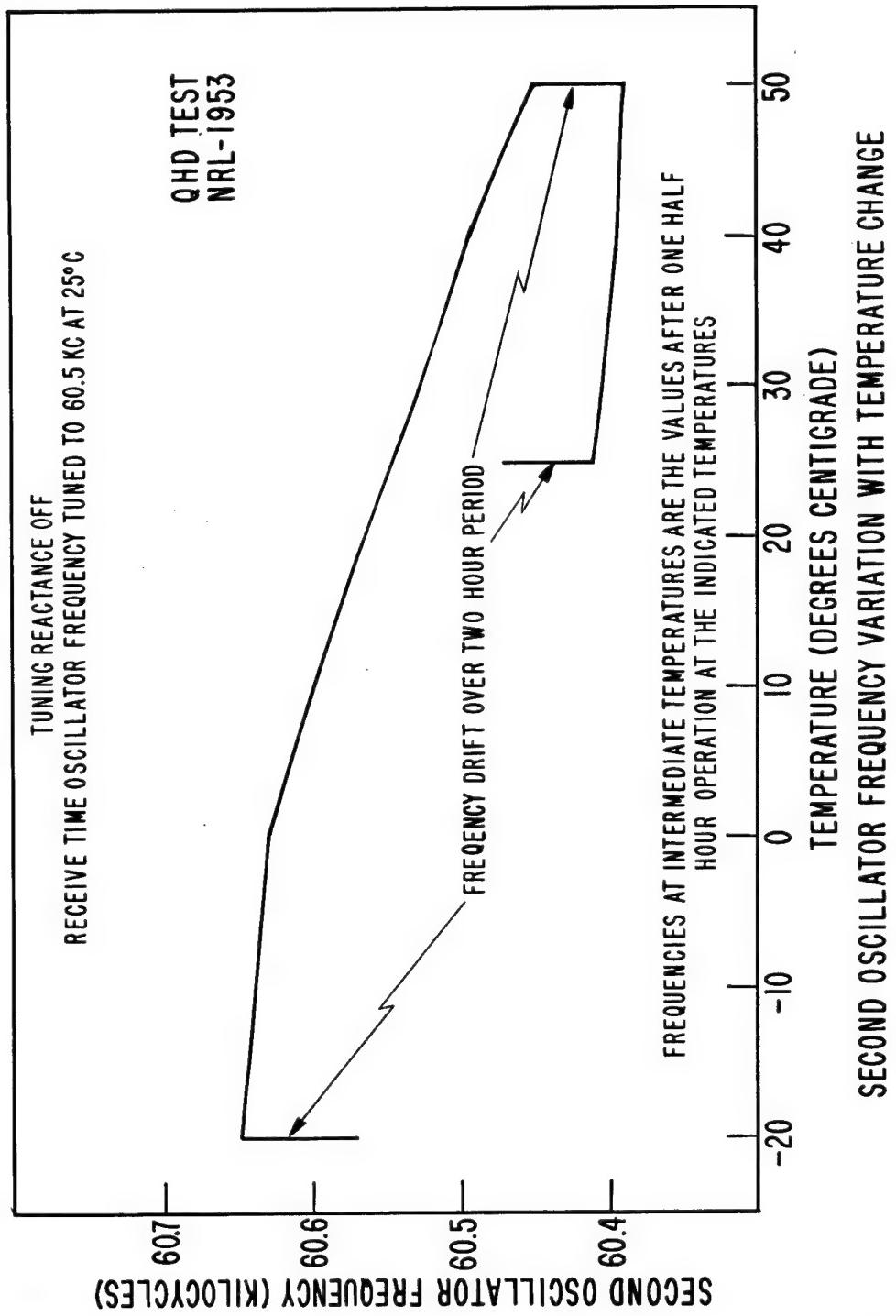
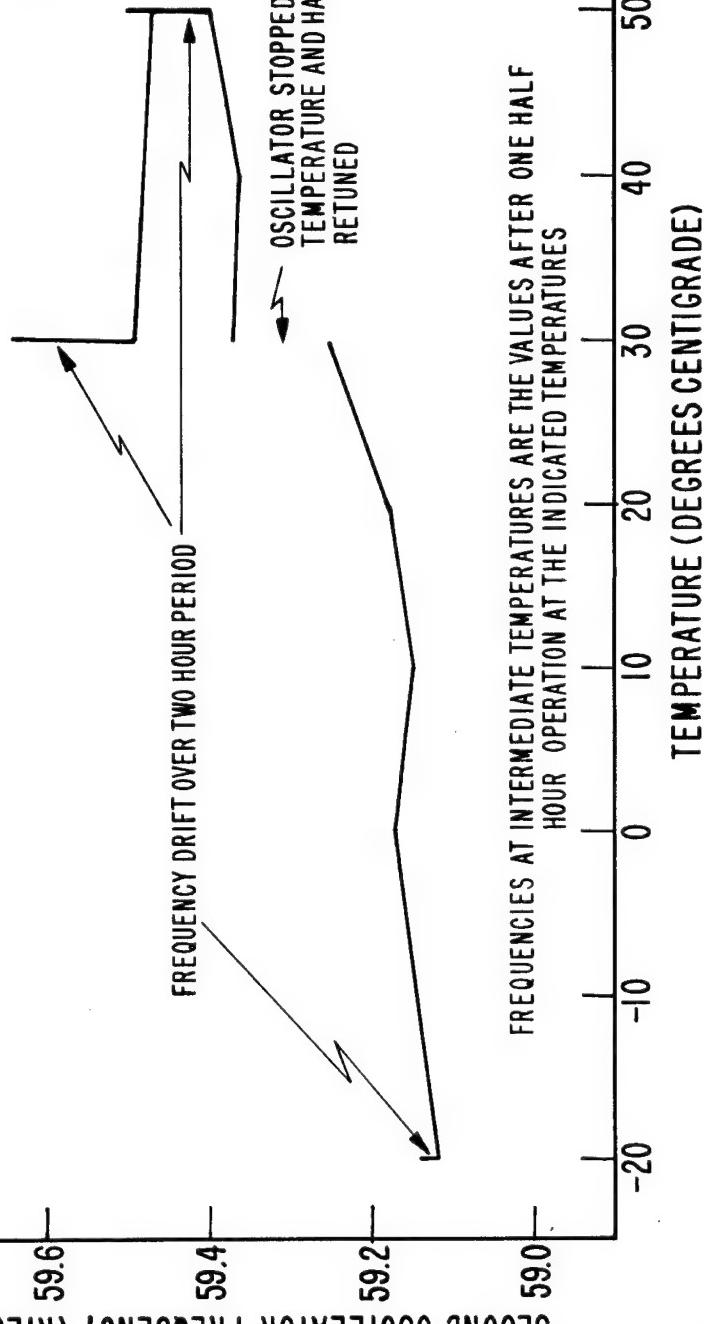


FIGURE 56

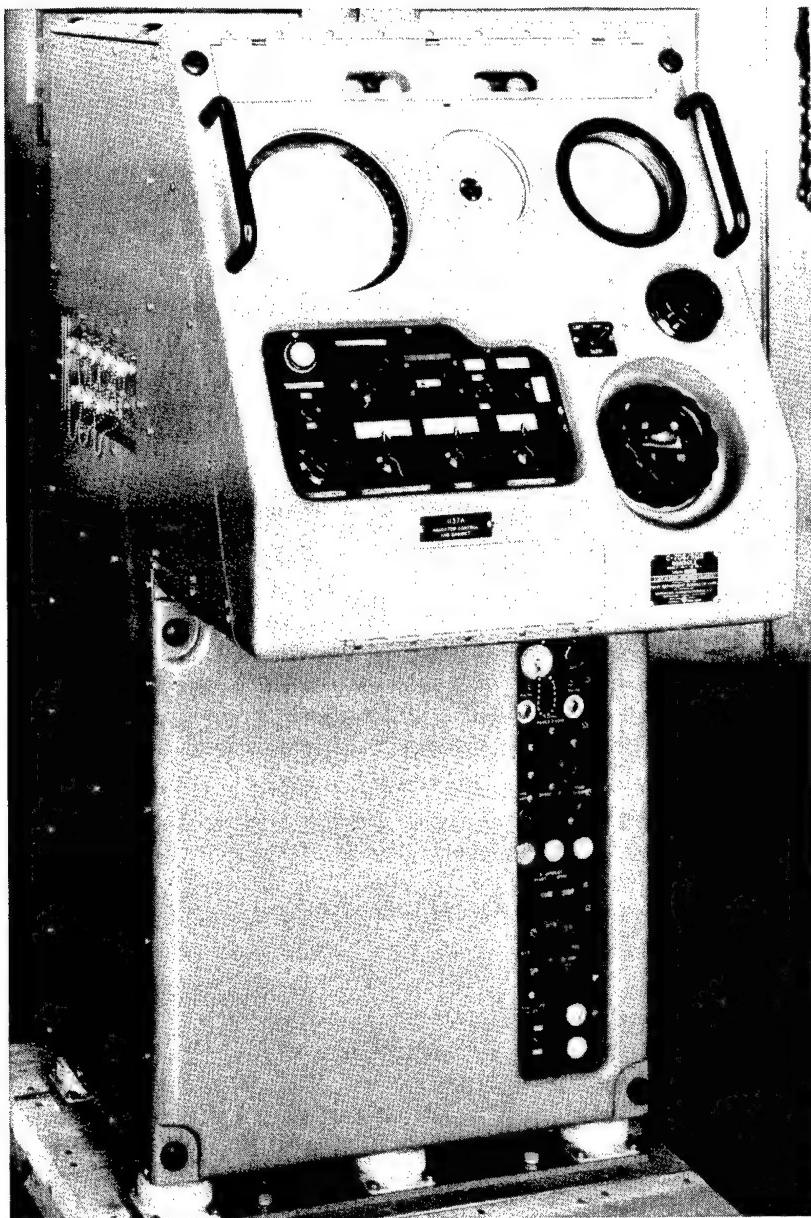
RECEIVE TIME OSCILLATOR FREQUENCY TUNED TO 60.5 KC AT 25°C
TUNING REACTION ON, AND WITH 26 KC APPLIED TO LISTENING RECEIVER

QHD TEST
NRL-1953

SECOND OSCILLATOR FREQUENCY VARIATION WITH TEMPERATURE CHANGE

FIGURE 57

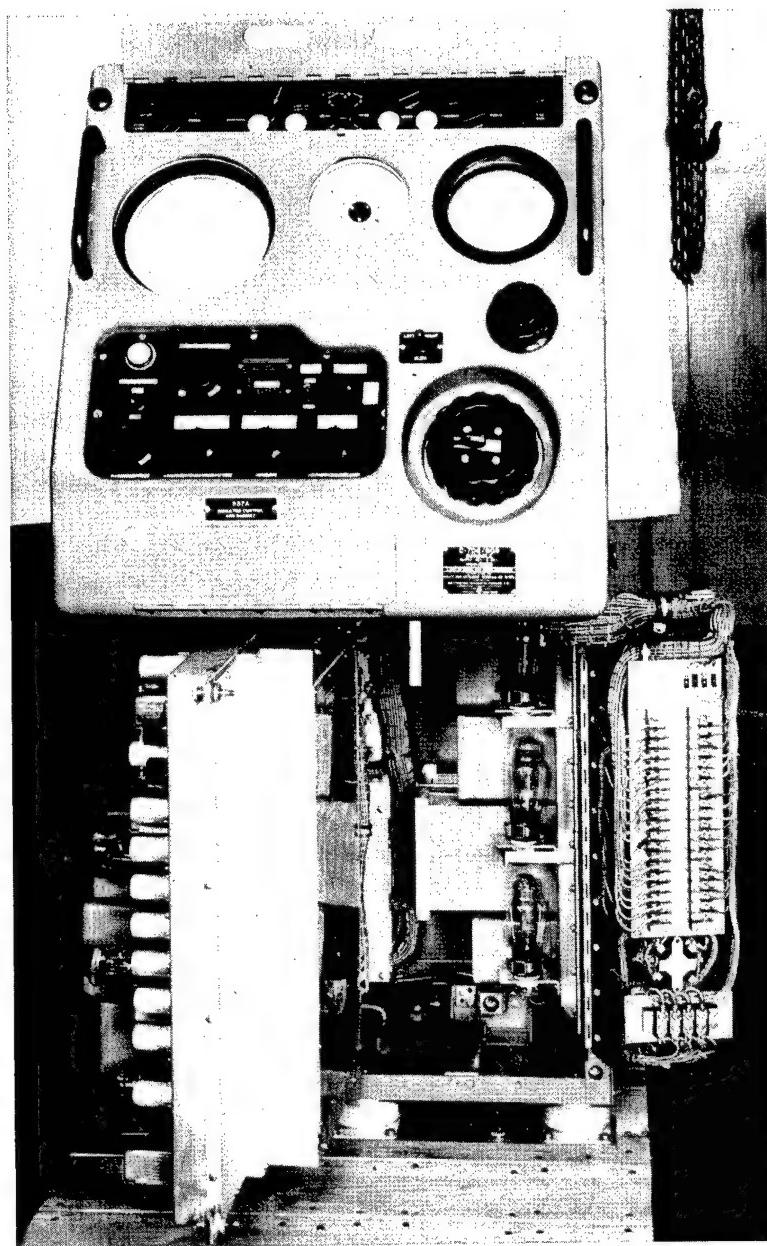
UNCLASSIFIED



CONSOLE ASSEMBLY
TYPE C-706/SQS

FIGURE 58

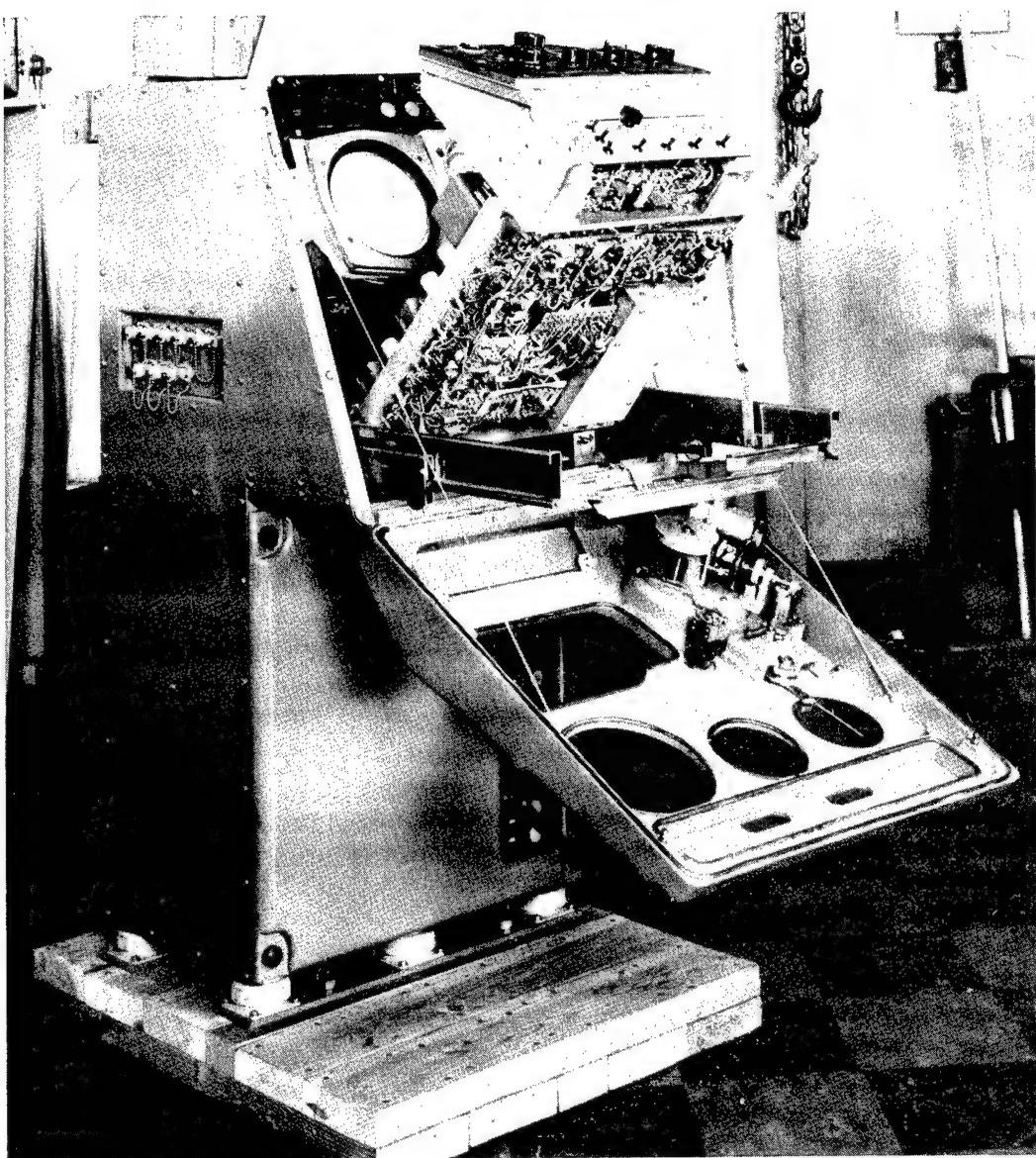
UNCLASSIFIED



CONSOLE ASSEMBLY
TYPE C-706/SQS
OPEN VIEW-BOTTOM

FIGURE 59

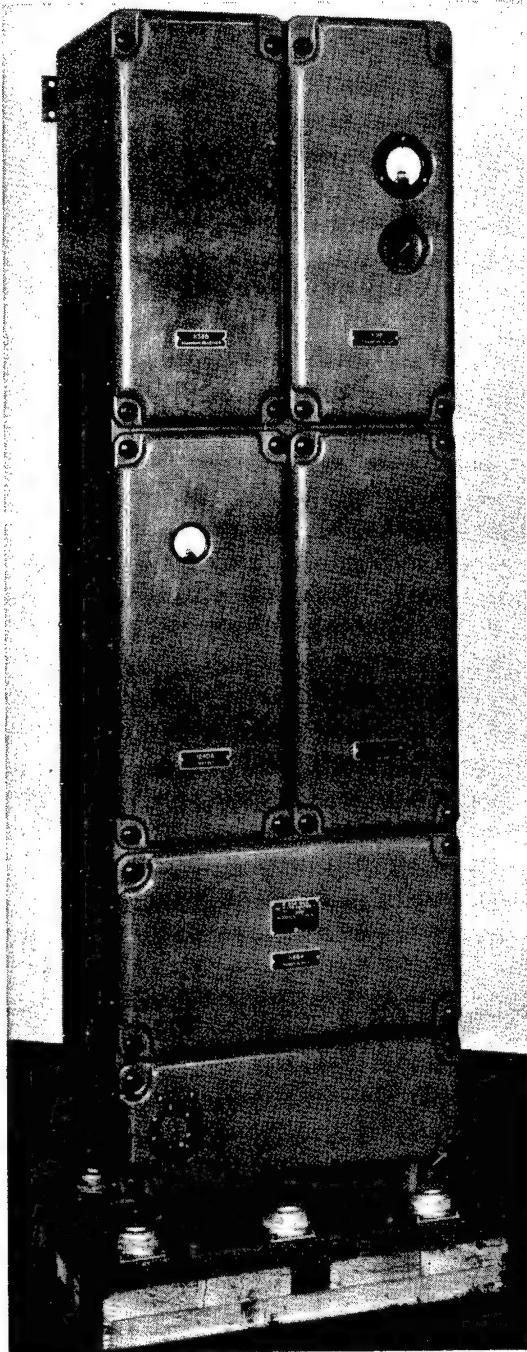
UNCLASSIFIED



CONSOLE ASSEMBLY
TYPE C-706/SQS
OPEN VIEW-TOP

FIGURE 60

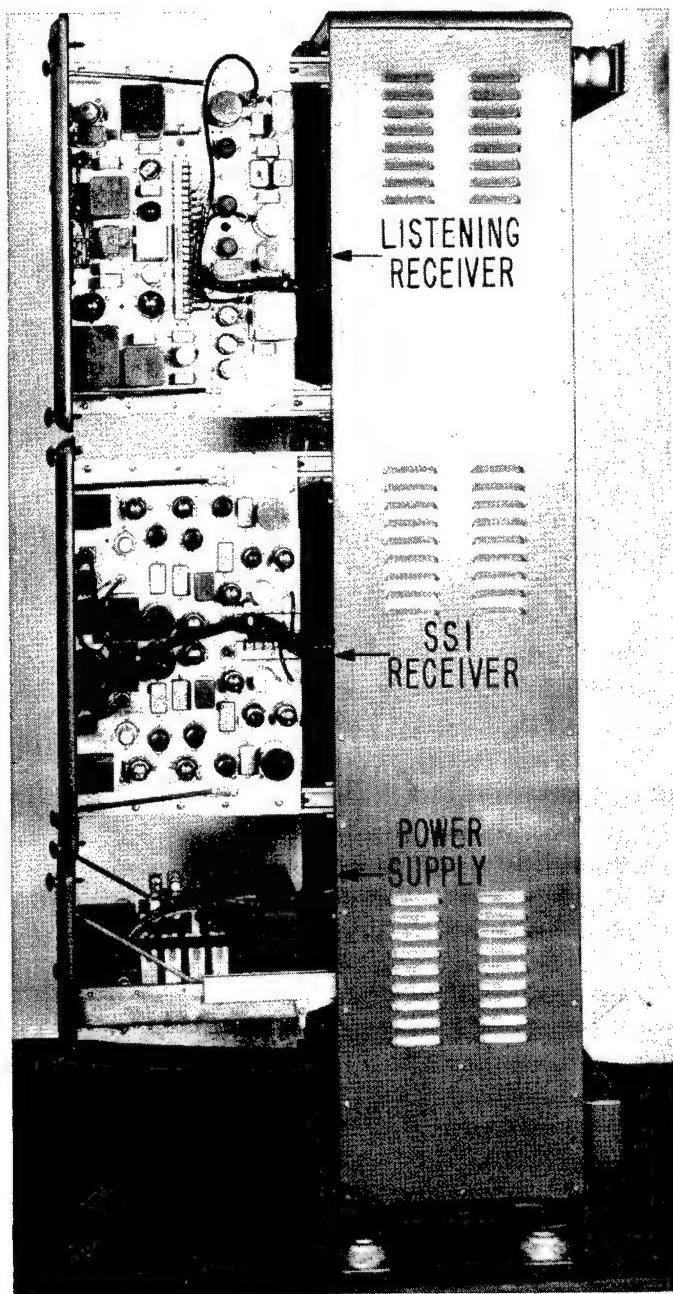
UNCLASSIFIED



RECEIVER ASSEMBLY
TYPE R-354/SQS

FIGURE 61

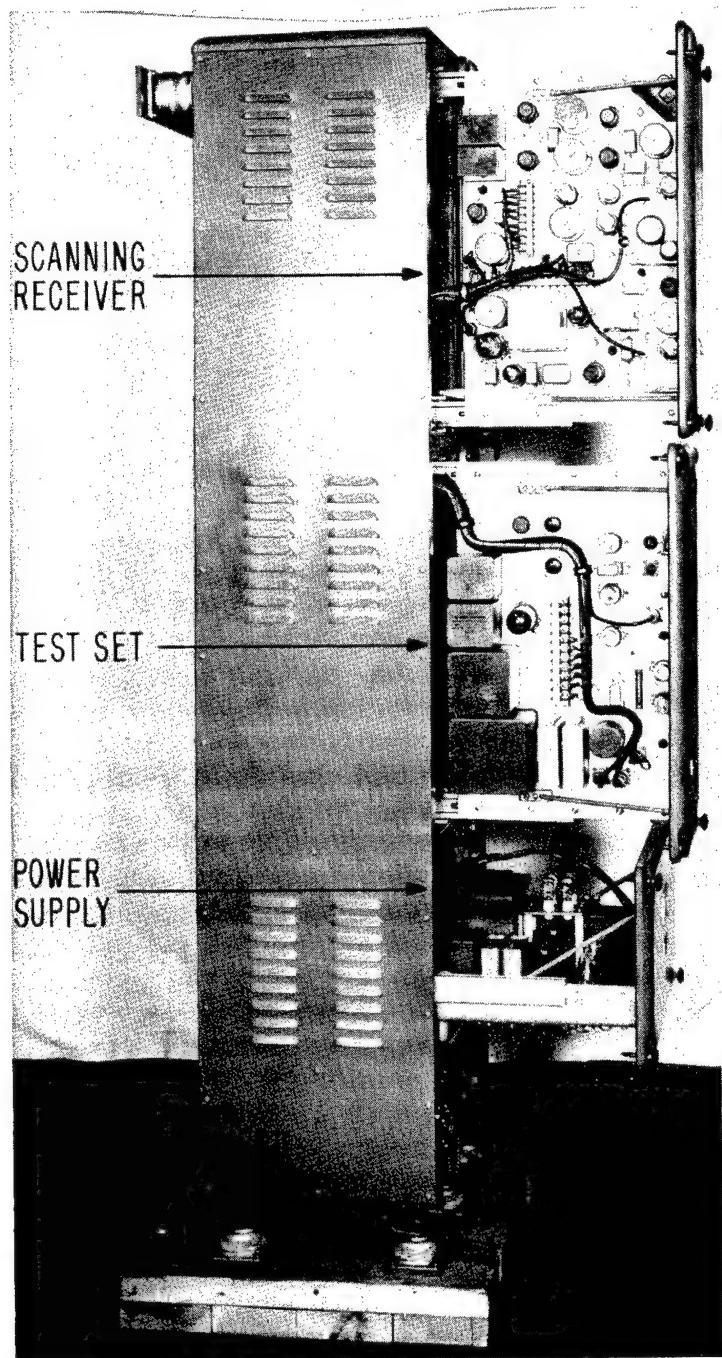
UNCLASSIFIED



RECEIVER ASSEMBLY
TYPE R-354/SQS
RIGHT SIDE VIEW

FIGURE 62

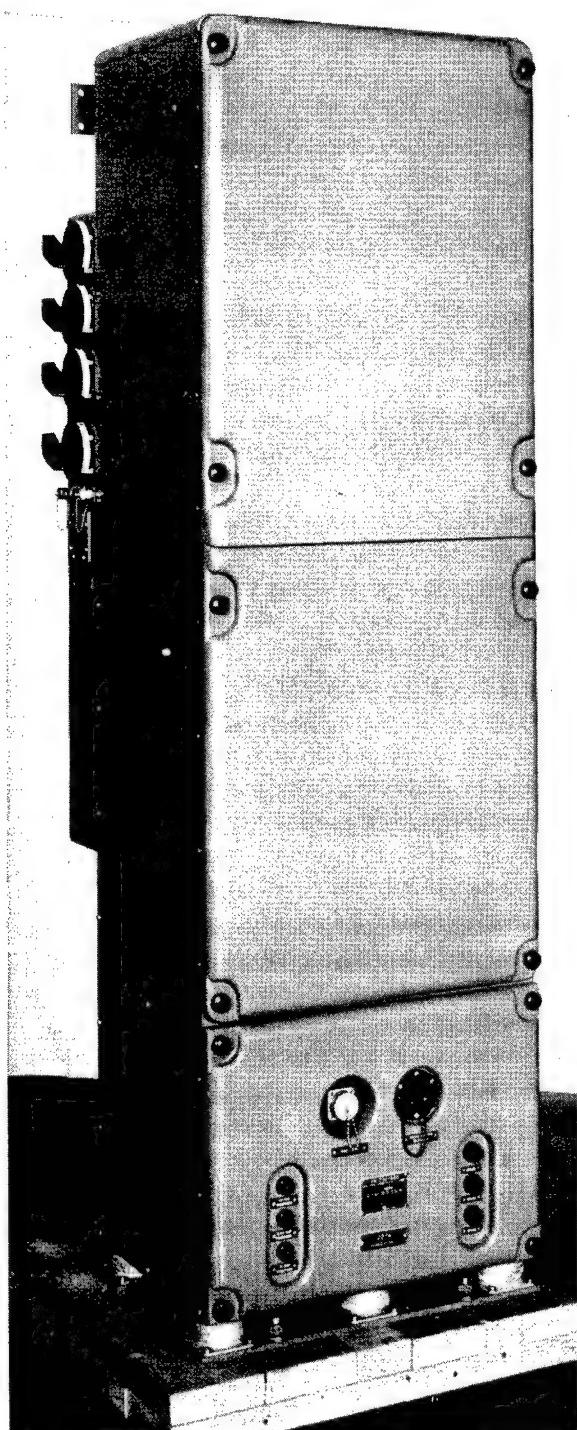
UNCLASSIFIED



RECEIVER ASSEMBLY
TYPE R-354/SQS
LEFT SIDE VIEW

FIGURE 63

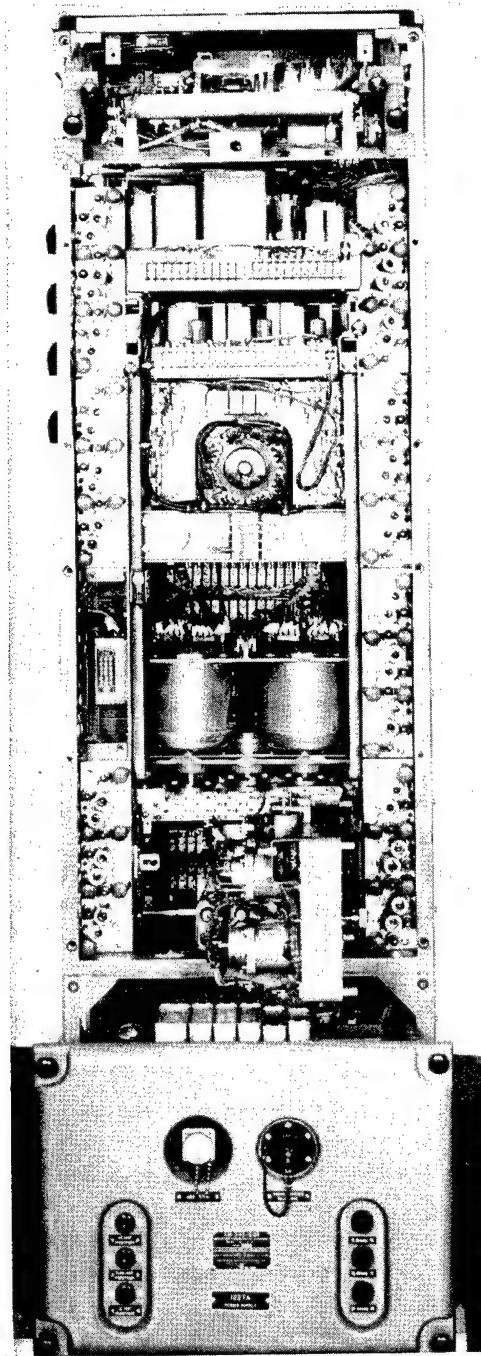
UNCLASSIFIED



AMPLIFIER-COMMUTATOR ASSEMBLY
TYPE AM-392/SQS

FIGURE 64

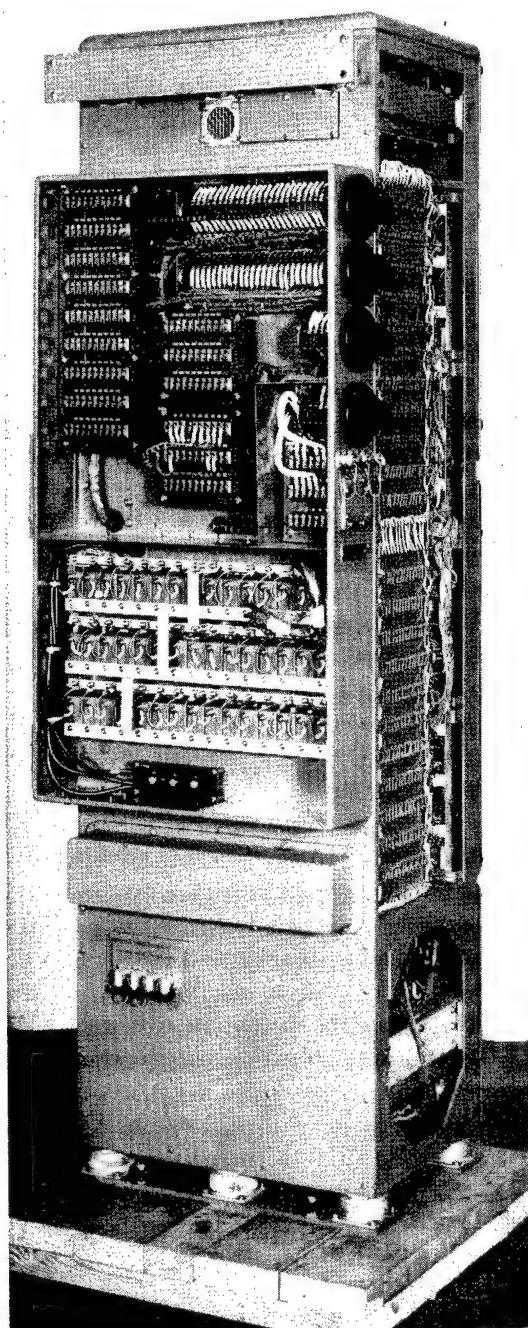
UNCLASSIFIED



AMPLIFIER-COMMUTATOR ASSEMBLY
TYPE AM-392/SQS
FRONT VIEW-OPEN

FIGURE 65

UNCLASSIFIED



AMPLIFIER-COMMUTATOR ASSEMBLY
TYPE AM-392/SQS
REAR VIEW

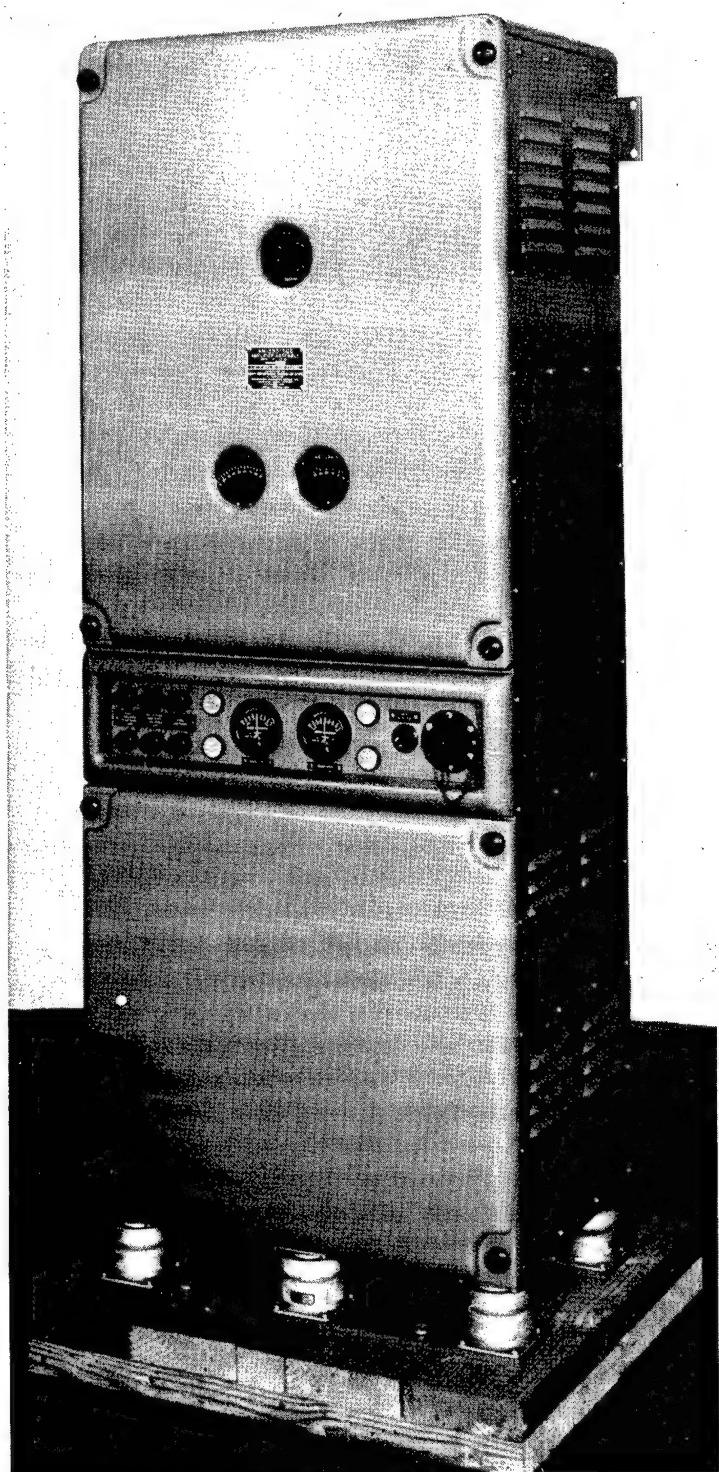
FIGURE 66

[REDACTED]

[REDACTED]

[REDACTED]

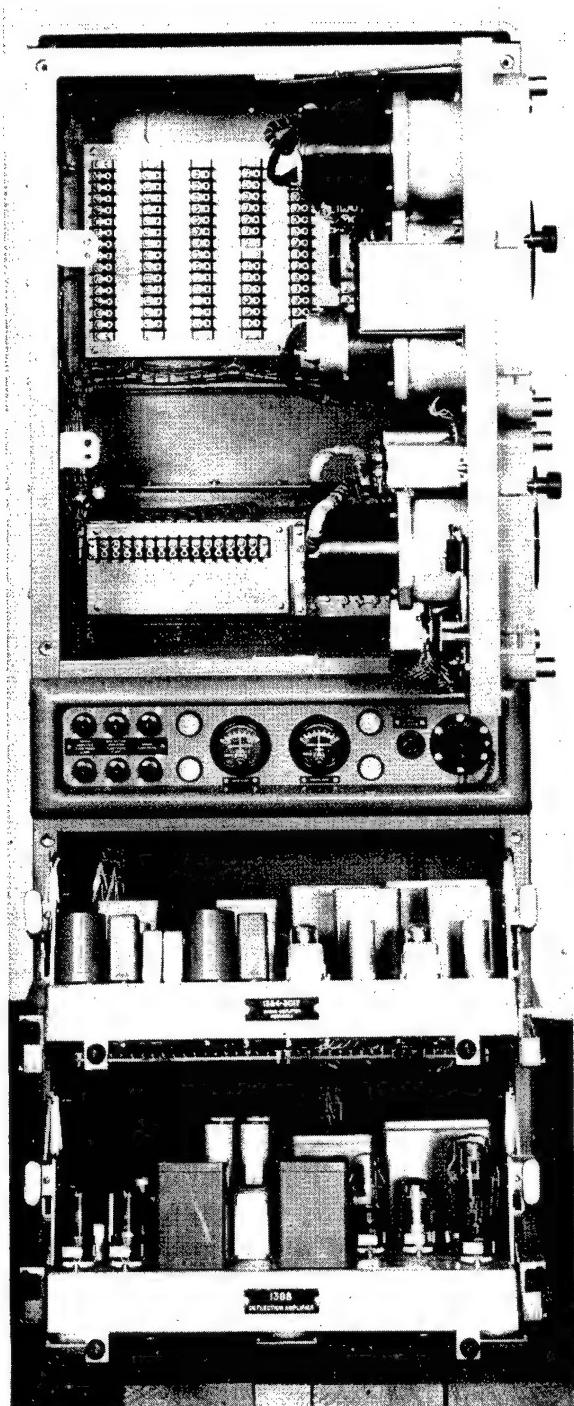
UNCLASSIFIED



SERVO AMPLIFIER ASSEMBLY
TYPE AM-393/SQS

[REDACTED]
[REDACTED]
[REDACTED]
FIGURE 67

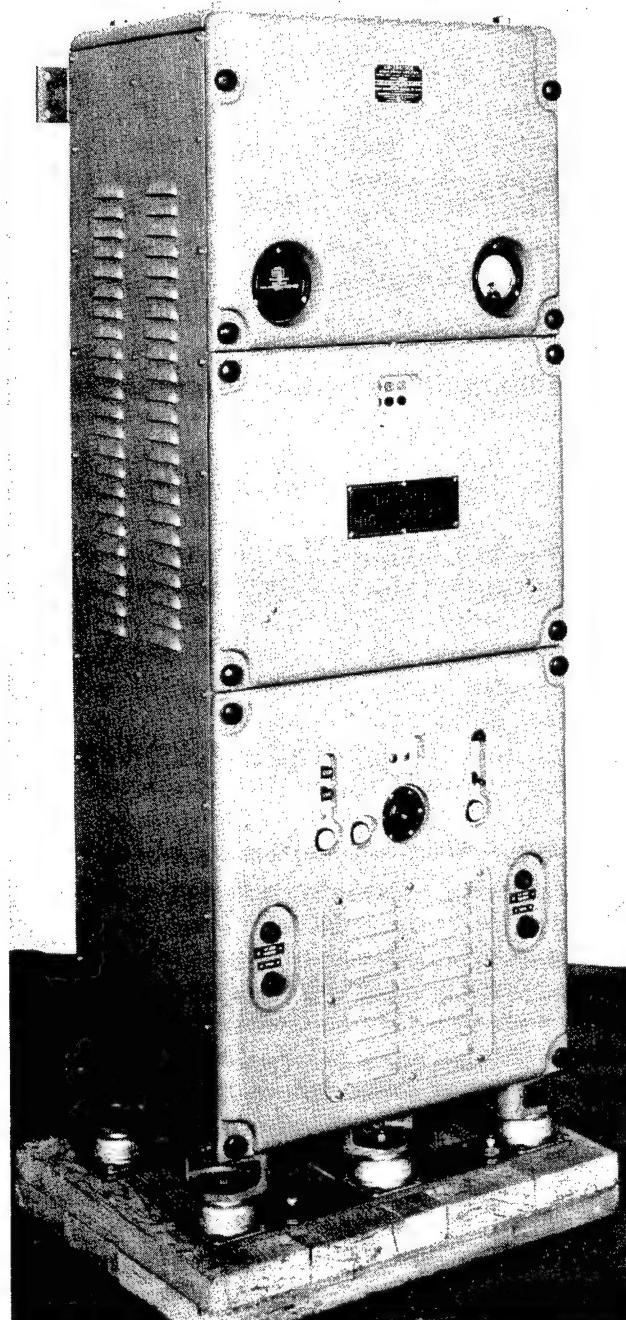
UNCLASSIFIED



SERVO AMPLIFIER ASSEMBLY
TYPE AM-393/SQS
FRONT VIEW-OPEN

FIGURE 68

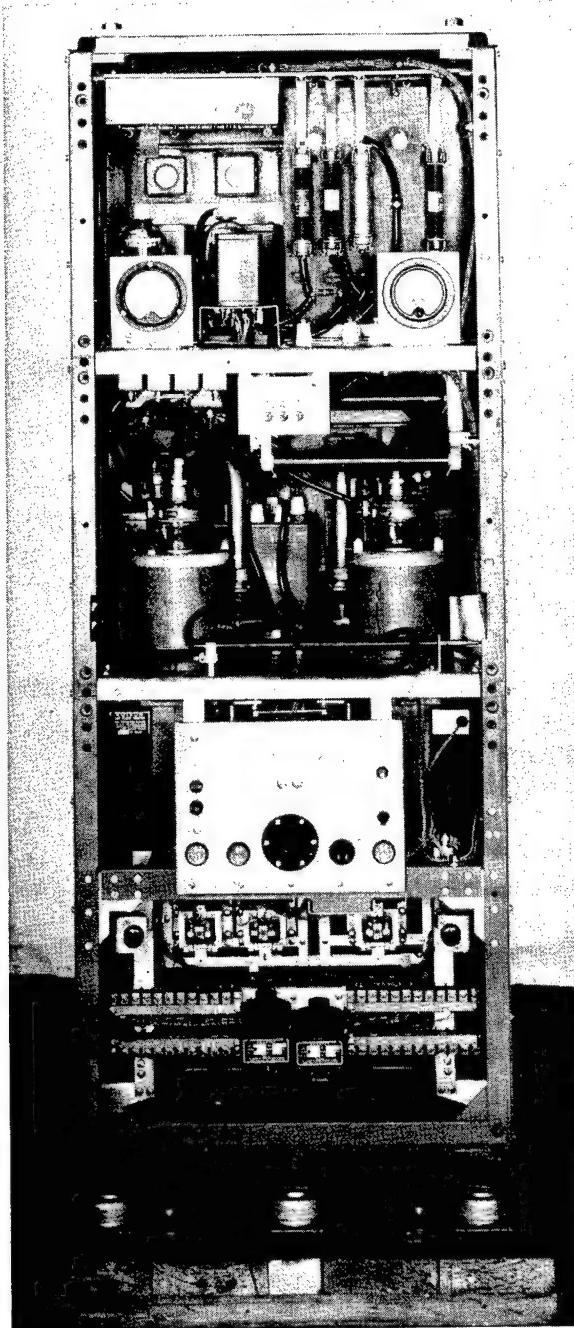
UNCLASSIFIED



SONAR DRIVER-AMPLIFIER
TYPE AM-394/SQS

FIGURE 69

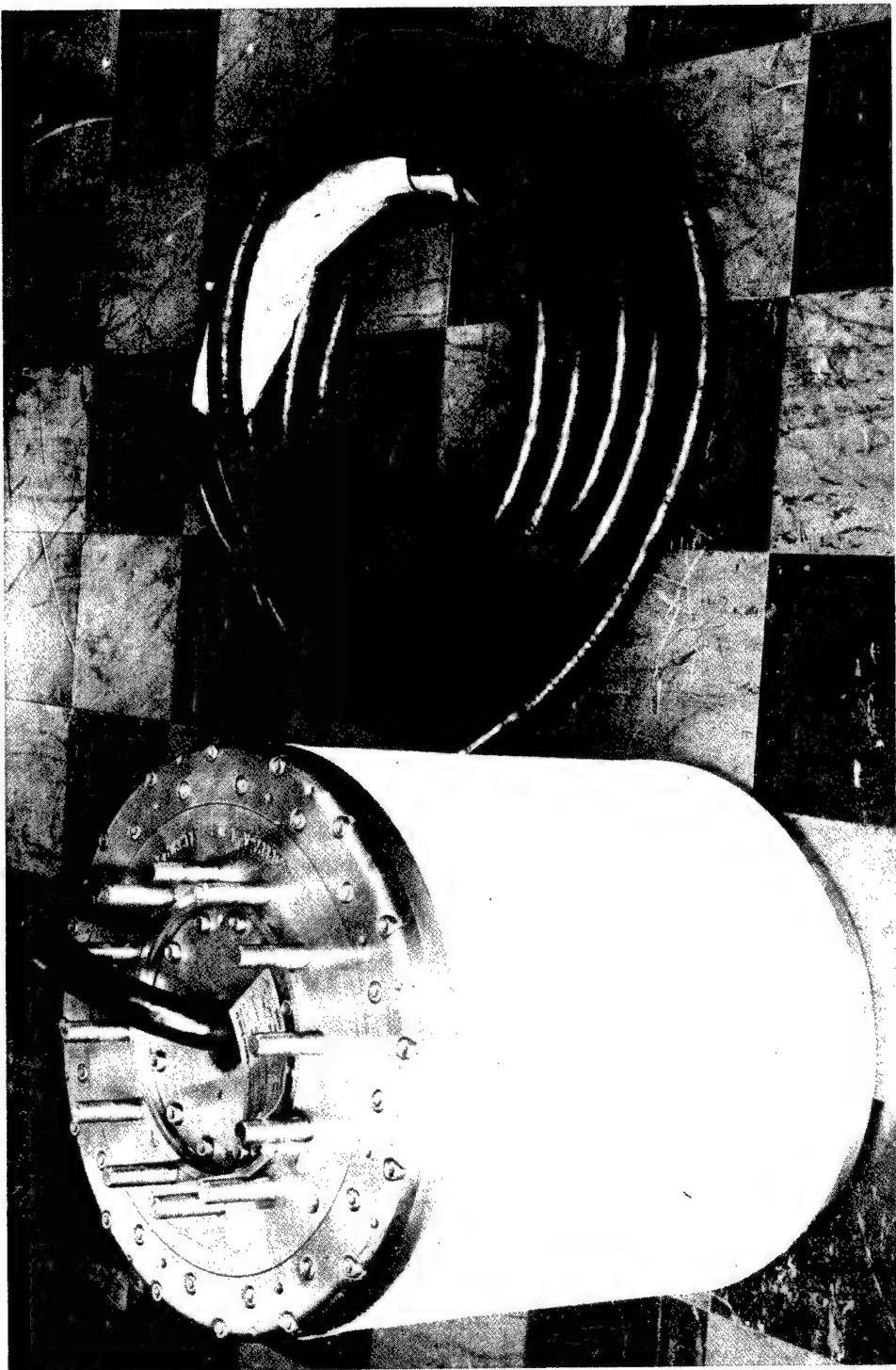
UNCLASSIFIED



SONAR DRIVER-AMPLIFIER
TYPE AM-394/SQS
FRONT VIEW-OPEN

FIGURE 70

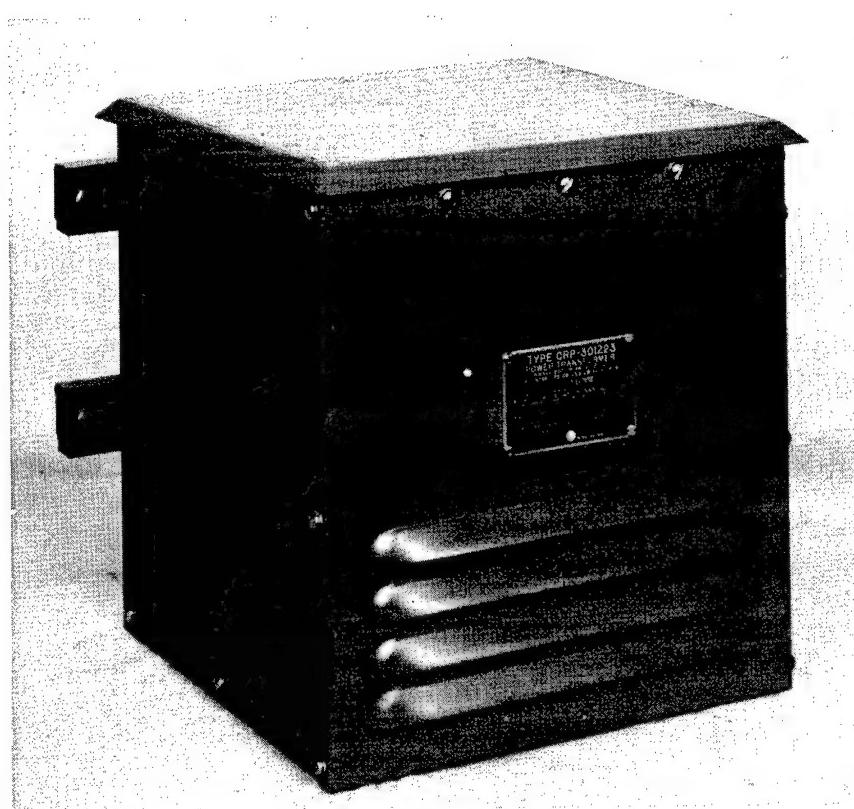
UNCLASSIFIED



TRANSDUCER-TYPE 51117-A

FIGURE 71

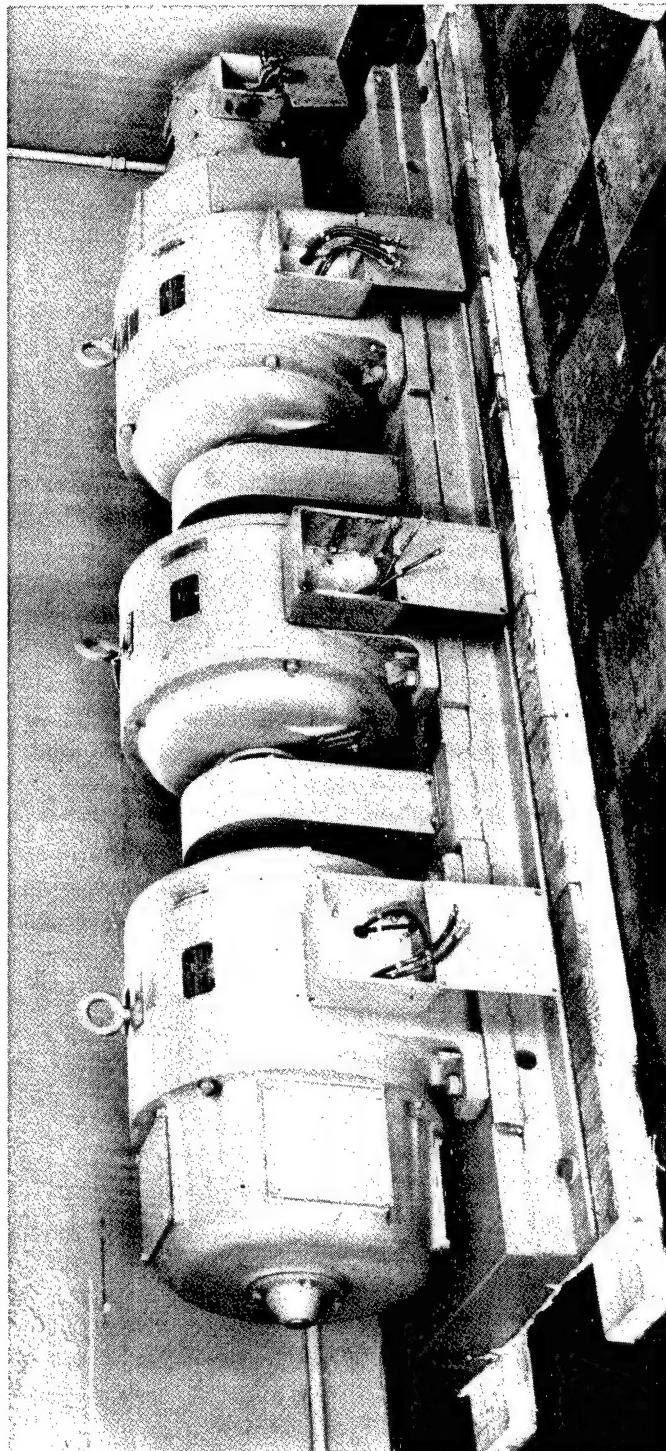
UNCLASSIFIED



POWER TRANSFORMER
TYPE CRP-301223

FIGURE 72

UMLAUFSTELLE



MOTOR-GENERATOR ASSEMBLY
TYPE PU-200/U

FIGURE 73

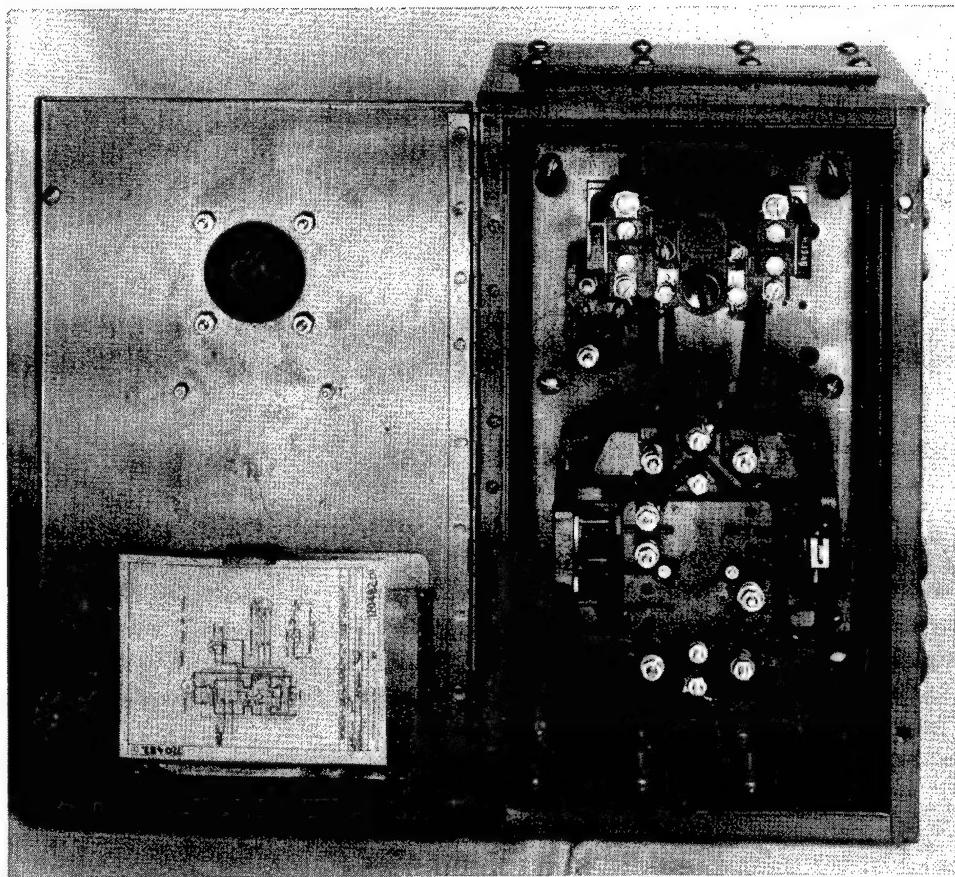
UNCLASSIFIED



MOTOR STARTER
TYPE CAE-211981

FIGURE 74

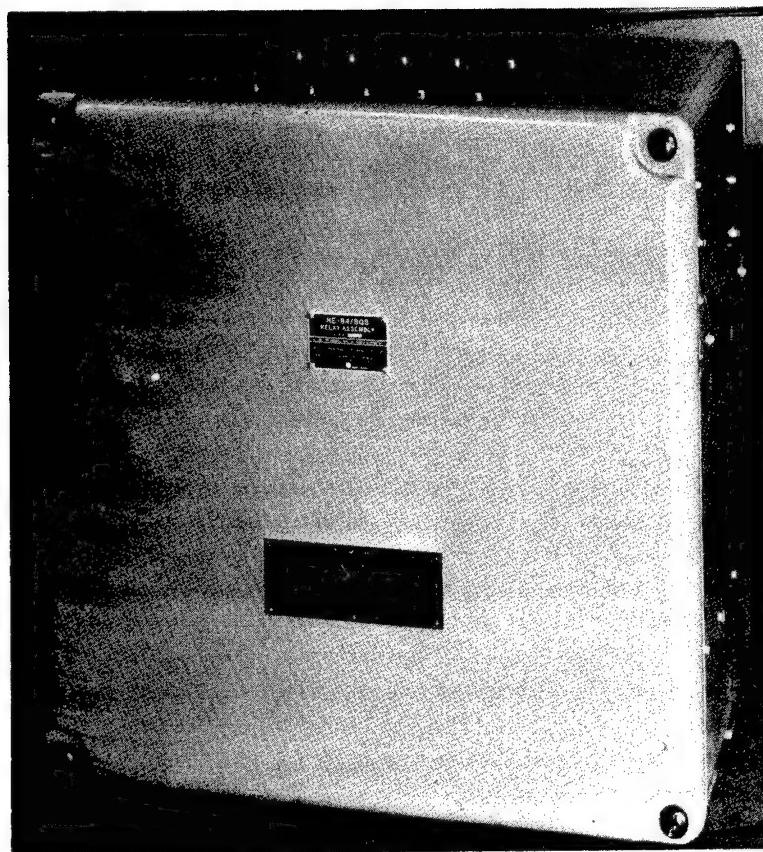
UNCLASSIFIED



MOTOR STARTER
TYPE CAE-211981
OPEN VIEW

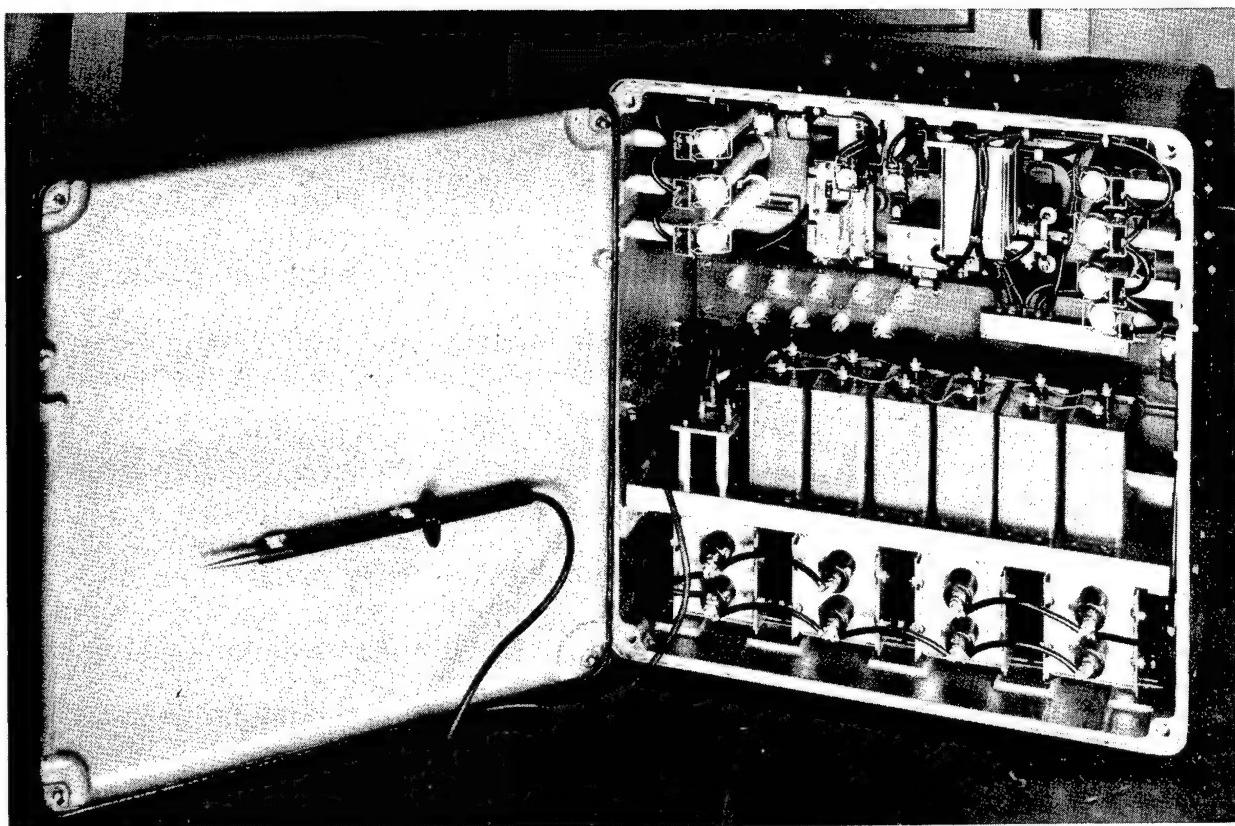
FIGURE 75

UNCLASSIFIED



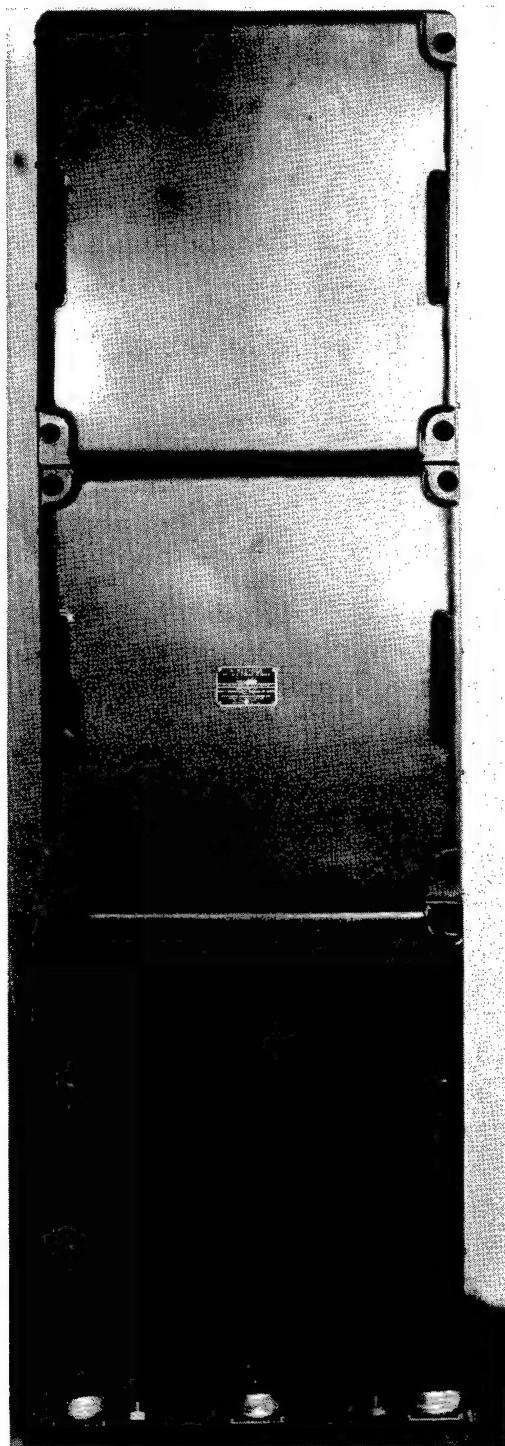
RELAY ASSEMBLY
TYPE RE-84/SQS

FIGURE 76



RELAY ASSEMBLY
TYPE RE-84/SQS
OPEN VIEW

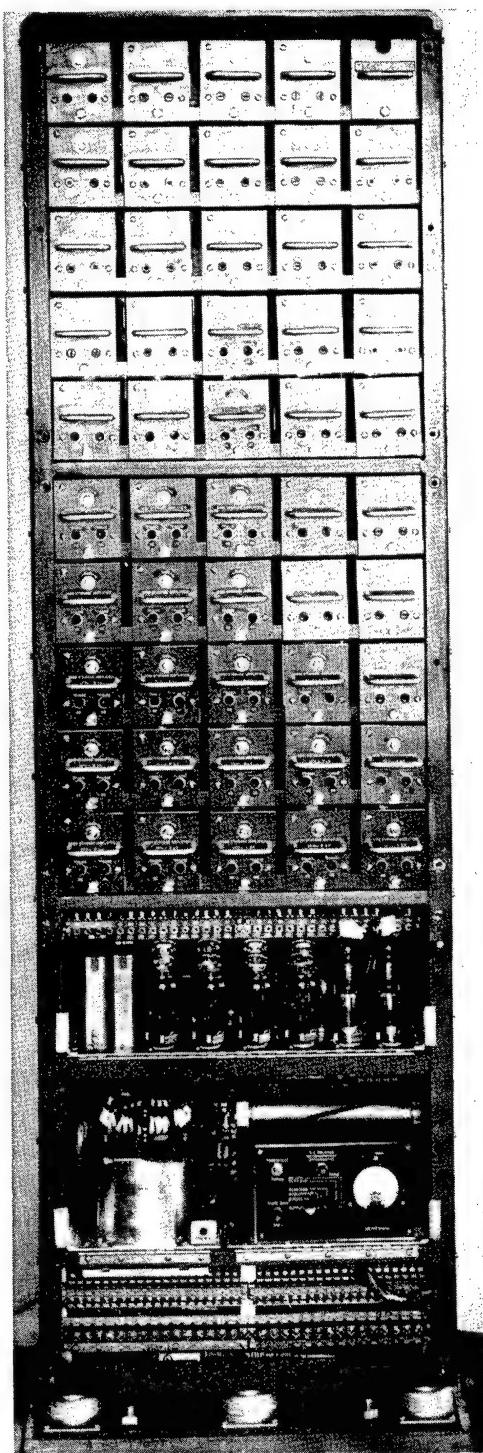
UNCLASSIFIED



RECEIVER-STORAGE SCANNER ASSEMBLY
TYPE R-522/SQS

FIGURE 78

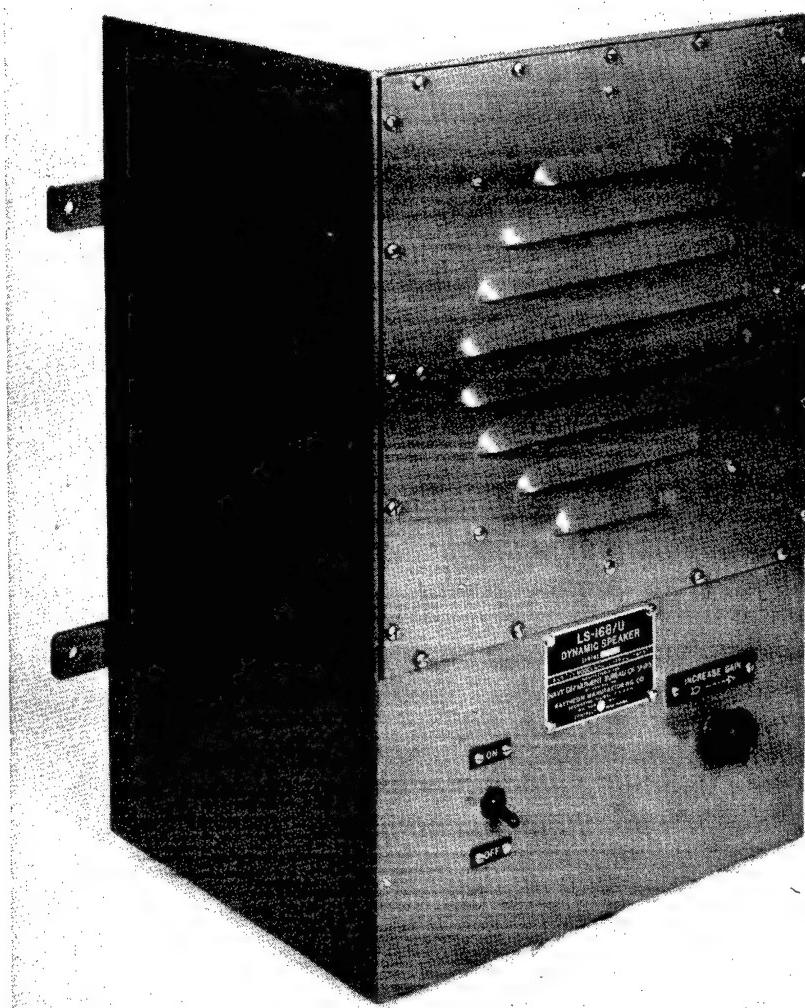
UNCLASSIFIED



RECEIVER-STORAGE SCANNER ASSEMBLY
TYPE R-522/SQS
FRONT VIEW-OPEN

FIGURE 79

UNCLASSIFIED



LOUDSPEAKER UNIT
TYPE LS-168/U

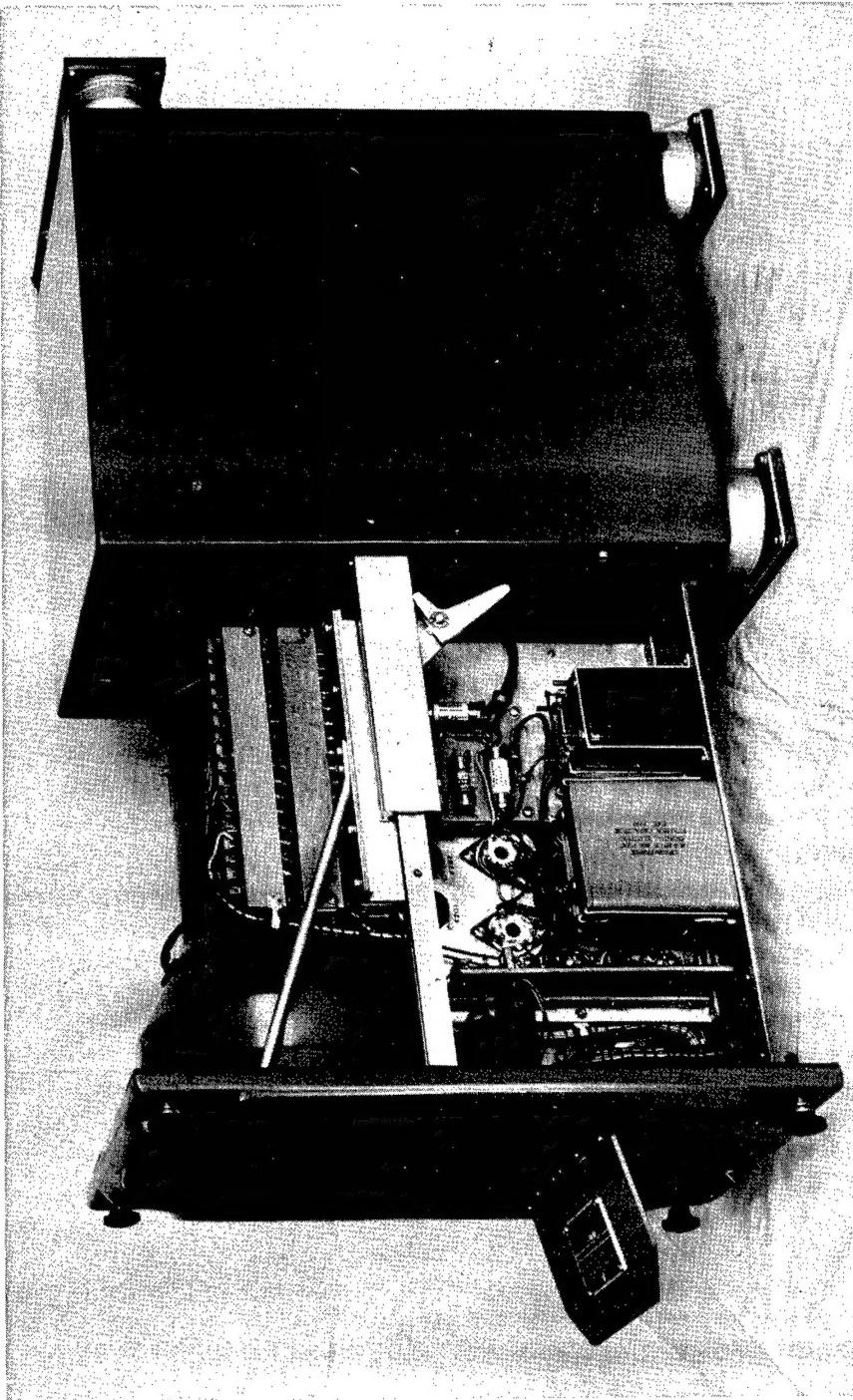
FIGURE 80

UNCLASSIFIED



AZIMUTH RANGE INDICATOR
TYPE IP-95/SQS
(REMOTE PPI)

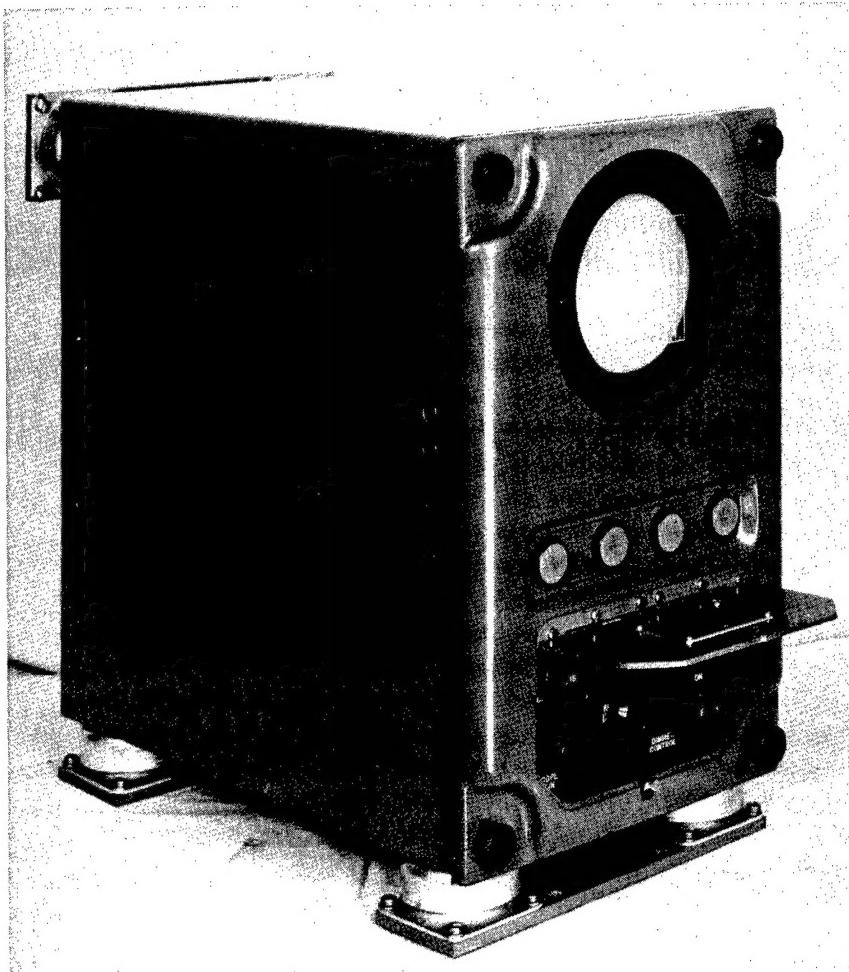
FIGURE 81



AZIMUTH RANGE INDICATOR
TYPE IP-95/SQS
(REMOTE PPI)
SIDE VIEW

FIGURE 82

UNCLASSIFIED



AZIMUTH RANGE INDICATOR
TYPE IP-96/SQS
(REMOTE SSI)

FIGURE 83

UNCLASSIFIED

AZIMUTH RANGE INDICATOR
TYPE IP-96/SQS
SIDE VIEW

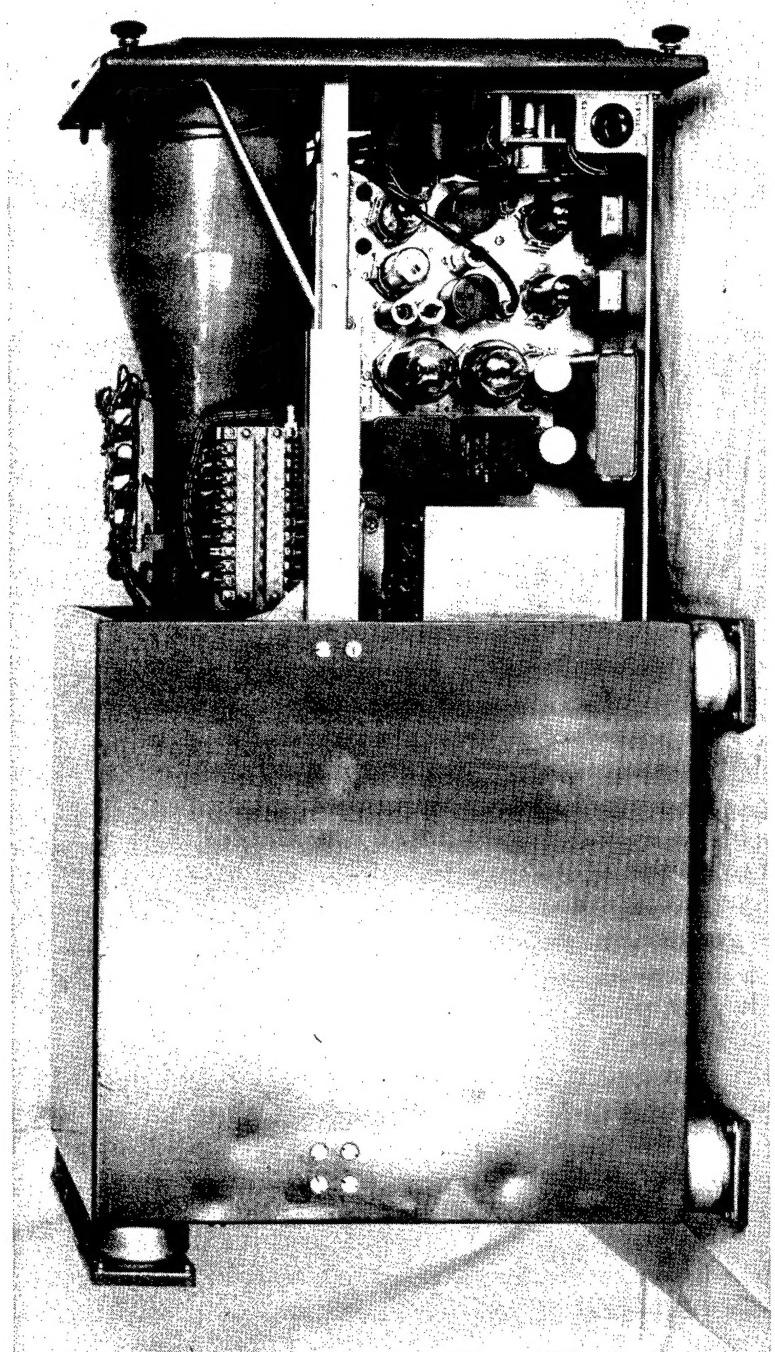
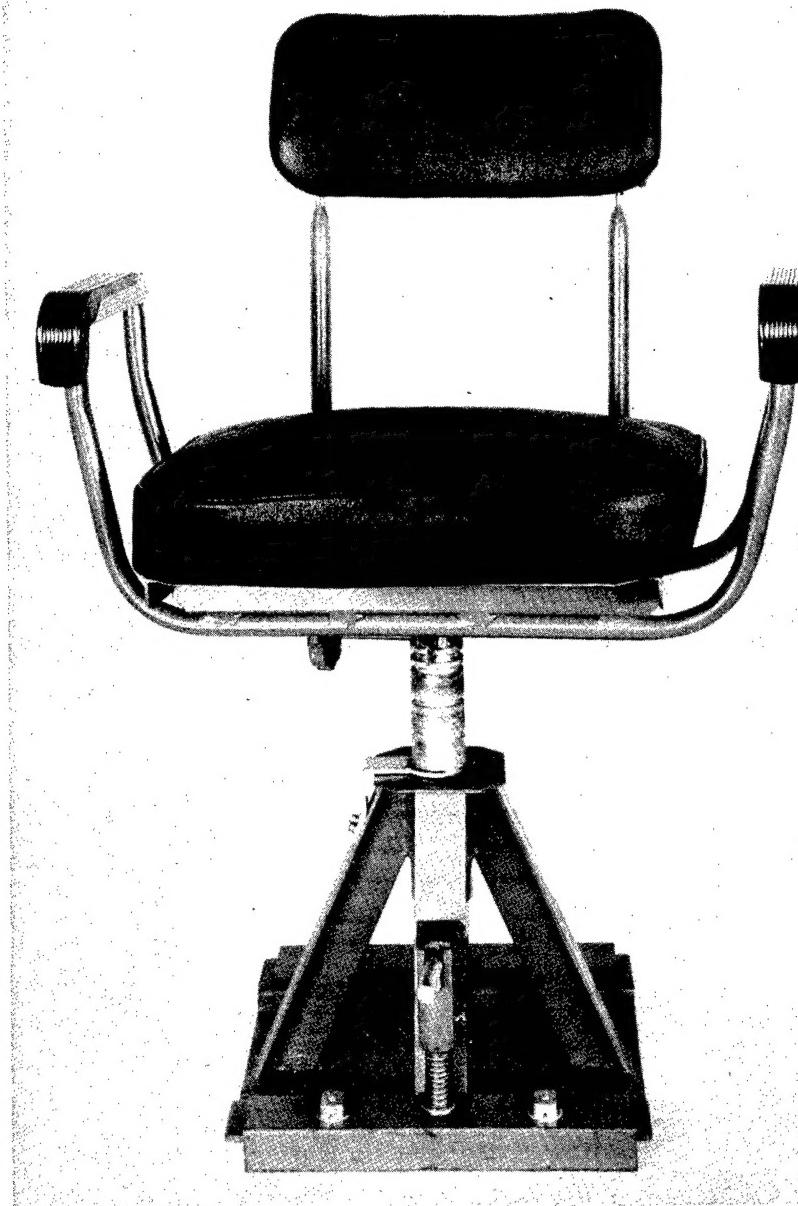


FIGURE 84



OPERATORS CHAIR
TYPE CRP-10691

FIGURE 85